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THE CINCHONA BOTANICAL STATION

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THE botanical laboratory and garden at Cinchona, in the Blue Mountains of Jamaica, which for the past ten years has been a tropical station of the New York Botanical Garden, is now to be maintained under the auspices of the British Association for the Advancement of Science, with the cooperation of the Jamaican government. The British Association is concerned primarily in making Cinchona available for British investigators, but it is believed that, except when the laboratory is taxed to its capacity by appointees of this association, its privileges will be extended, upon the recommendation of the Jamaican government, to properly accredited American botanists.

The opening of a new chapter in the history of this long-established seat of botanical activity makes this a fitting time to call attention to the work that has been done at this laboratory during the past forty years, and to its peculiar advantages in location as a botanical station. We may also note the evidence for the need of such a laboratory, and the character of its possible service to botanical science. With the general appreciation of the variety of plant material and other advantages to be had at this laboratory, it is believed that Cinchona will be more and more resorted to by investigators working on those botanical problems which can best be studied with organisms living under tropical or subtropical conditions.

The need of a botanical laboratory in the western tropics, which could offer the facilities and give the stimulus afforded to old-world botanists by the Dutch garden at Buitenzorg, in Java, has long been recognized by American botanists. It is true that biological explorers in quest of new forms, or of new evidence concerning the distribution of known forms, have been searching since the days of Hans Sloane (1687) and Humboldt (1799–1804) through many parts of the western tropics. The plant taxonomists of Europe, of the U. S. National Herbarium, of

the Columbian Field Museum, and especially of the New York Botanical Garden, have recently made extensive collections in the continental and Antillean portions of the American tropics. But facilities have been lacking for working out the life-histories or the physiology and ecology of tropical and subtropical seaweeds, as this has been done at Naples and Ceylon; the chance has been wanting to select, study and carefully preserve developmental stages of tropical mosses, ferns and seed plants, and to make investigations of the physiology of growth, nutrition and other activities of plants near the equator, as these have been made at Buitenzorg. This sort of opportunity for studying tropical plants where they must be studied—in their tropical surroundings— has seldom been offered to American investigators until within the last decade. The more or less temporary summer laboratories established in the western tropics have been located directly upon the seacoast, primarily with a view to their fitness for zoological work. They have usually proved unattractive to botanists engaged in studies other than those upon marine algae. This has been largely true of the summer laboratories established by the Johns Hopkins University in the Bahamas and Jamaica, by Harvard University in Bermuda and by the Carnegie Institution on the Dry Tortugas. It is evident, therefore, that for many kinds of botanical research a laboratory must be established at a site selected with these in view—in other words, it must be primarily a botanical station.

A serious attempt to arrange for the establishment of an American tropical laboratory was made by certain of the botanists of this country in 1897. The desirability of such a laboratory was pointed out by *The Botanical Gazette,* and a commission composed of D. T. MacDougal, D. H. Campbell, J. M. Coulter and W. G. Farlow was chosen to select a site. This Tropical Laboratory Commission, after profiting by such information and suggestions as they could obtain, and after two of its members, Drs. MacDougal and Campbell, had visited Jamaica in 1897, was inclined to favor that island as the location for the laboratory. During the presence of these two commissioners in Jamaica they were aided by Hon. William Fawcett, late director of Public Gardens and Plantations, William Harris, superintendent of Public Gardens and Plantations and Professor James E. Humphrey, of the Johns Hopkins University, who was at this time in charge of the Johns Hopkins Laboratory, established at Port Antonio. The sad fate of Professor Humphrey and of that promising young zoologist Franklin Story Conant, as victims of the unwonted visitation of yellow fever to Jamaica, undoubtedly checked the enthusiasm of many who had been interested in establishing a tropical laboratory. The anticipated encouragement and cooperation were not given to the commission, and, in consequence, the search for a site and all further work on the project were, for the time, abandoned. The project was not again taken up by American botanists or institutions during the following six years.

In August, 1903, the Jamacian government, having abandoned Cinchona cultivation, decided to lease the Cinchona property. Through the suggestion of the late Lucien M. Underwood and the writer, and by the prompt action of Director N. L. Britton and Dr. D. T. MacDougal, Cinchona was leased by the New York Botanical Garden. It was maintained by the garden as a laboratory, and as a substation for the propagation of tropical plants. The director of the garden also placed the laboratory and other equipment at the disposal of botanical investigators, of whom more than thirty have worked at Cinchona during the past ten years.

In the last decade, it is true, several other botanical laboratories, all of them primarily for experiment-station work, have been organized in the American tropics. Two of these were maintained by commercial organizations in Mexico. Of the other three, two, at Miami, Florida, and Mayaguez, Porto, Rico, are supported by the United States, and a third, at Paramaribo, is maintained by the government of Dutch Guiana. At none of these has much botanical research thus far been carried on, except the economic agricultural work of the regular staff members.

It is thus evident that the interest of American botanists desiring a tropical laboratory has centered about Cinchona for the past two decades. There is good reason to believe that this interest will continue and increase. When, therefore, it was learned that Cinchona, the only station in the western tropics for the study of pure botany, was not to be again leased by the New York Botanical Garden, the Botanical Society of America, meeting in Cleveland, attempted to secure the continuation of the use of the Cinchona station for American botanists. For this purpose a committee was appointed consisting of D. S. Johnson (chairman), N. L. Britton and D. H. Campbell, and an appropriation was made to pay a year's rental, if this should be necessary, while more permanent arrangements were being perfected. Before the committee had had opportunity to act, it learned of the prospect that the Jamaican government would make the privileges of Cinchona available for American investigators. The publication of this account of Cinchona, and its advantages as a botanical station, may serve to indicate the interest of the committee in its work, and its appreciation of the encouragement given to botanical investigators of our country by the Jamaican government.

Location

The Hill Garden, or "Government Cinchona," as it is commonly called by Jamaican planters, is a reservation of many thousand acres, where the cinchona tree, from which Peruvian bark and quinine are obtained, was introduced 45 years ago. Here, and on the neighboring private plantations, it was grown for profit, until the cheaper labor and transportation in the parts of India and Java devoted to this crop greatly lowered the price of the bark.

Lying on a rugged spur stretching southward two miles from the main ridge of the Blue Mountains, the Cinchona reservation extends upward from the cleared slopes at the 4,500-ft. level to the well-wooded peaks 6,100 feet high, in the main range itself. Practically all the Blue Mountan country above the 4,500-foot level is reserved by the government as a water shed, and thus forms an immense area of mountain forest that may be used for floristic exploration and ecological study. At a spot commanding a remarkable prospect, on the shoulder near the south end of the spur, stands the Cinchona residence and laboratories, situated at an altitude of 4,900 feet. The house is the highest dwelling of any pretensions anywhere in the West Indies.

History

The idea of developing a hill garden, or "European garden," as he called it, was conceived by a governor of the colony, Sir Basil Keith, in 1774. He planned especially to introduce the cultivation of European vegetables in the cool, moist hill country. The plan was first realized in 1869, through the energy of a later governor, Sir John Peter Grant, whose primary object was the encouragement of the culture of Peruvian bark, coffee and tea. Here, in the early seventies, scores of acres were cleared and planted with seedlings of several species of *Cinchona*. These were derived from plants brought out of Peru in 1860 by Clements Markham. In 1874 the Jamaican government organized at Cinchona an experiment station, which became the center of botanical work in the island. A director's residence, other dwellings, offices, laboratories, greenhouses, servants' quarters and stables were erected. A beautifully planned garden was developed about these buildings, and planted with hundreds of subtropical and temperate-zone plants.

Here was stationed during the prosperous days of cinchona culture, nearly the whole botanical staff of the Department of Public Gardens and Plantations. For seven years, under Sir Daniel Morris (1879–1886), and eleven years under the Hon. William Fawcett (1886–1897), the staff was engaged in agricultural and in some purely botanical researches. Methods of propagating, cultivating, harvesting and curing cinchona, tea, etc., were studied. At a lower altitude experimental plantations were made of oranges, orris root, forage plants, and fiber plants such as China grass, which showed that these can be grown successfully in the Hills. The staff included a trained English gardener, William Nock, brought over to demonstrate the possibility of cultivating "English" vegetables in these higher parts of the island. This experiment was entirely successful, and in consequence the natives now grow these vegetables, then carry them as head loads for 15 or 20 miles over the mountain trails to the Kingston market. Besides these purely agricultural investigations, important taxonomic studies were made of

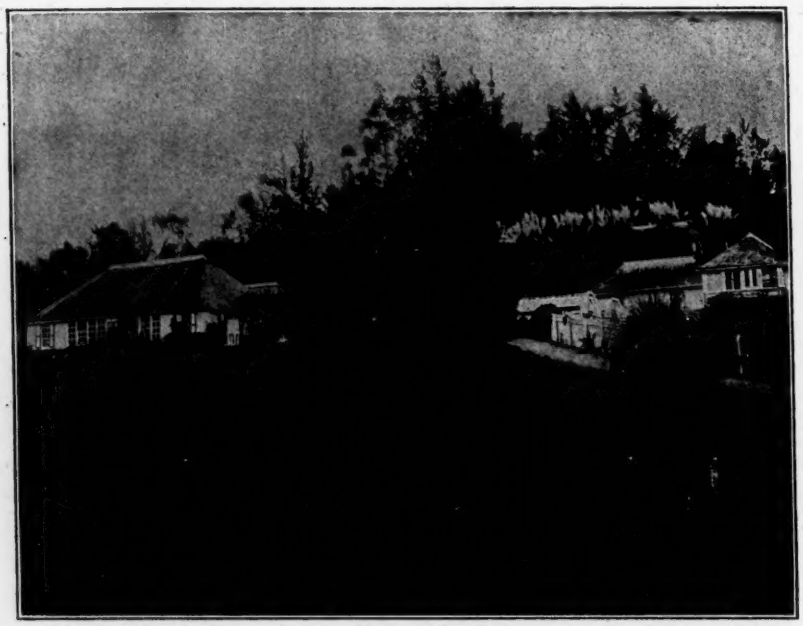
the flowering plants of this most interesting part of Jamaica by Messrs. William Fawcett and William Harris, of the staff. Diligent search for new forms in the more inaccessible regions was made especially by Mr. Harris, while G. L. Jenman, then superintendent of Castleton Gardens, studied the ferns of this area. Hundreds of species of mosses, ferns and seed plants new to the island, and to science, were found by these workers. *The Flora of Jamaica,* now being published by Fawcett and Rendle from the British Museum, was initiated at Cinchona. Records were also made for twenty years of the temperature and rainfall at several stations in this region, including Blue Mountain Peak, at 7,423 feet elevation.

Some sixteen years ago the staff was removed to new headquarters at Hope Gardens, near Kingston, from which the lowland agriculture, now of most importance to the island, can be more readily studied and aided. For a number of years after the removal of headquarters, the Cinchona Station was not occupied, except occasionally as a summer retreat from the heat of the plains, by the governor, or other island officials, or by visiting botanists. For example, it was used as a base for botanical work by Campbell in 1897, by Harshberger in 1902, and by Underwood, Maxon, Johnson and Shreve in 1903.

The importance of the later history of Cinchona, during its lease by the New York Botanical Garden, has already been suggested. Aside from being used as a propagating station, it has been the base for much purely botanical work by Americans and Englishmen. Researches have come from Cinchona during the past decade by workers from the New York Botanical Garden, the United States National Museum, Columbia, Yale and Johns Hopkins Universities, and Wellesley College. Important studies of the ecological distribution of Blue Mountain plants have been made here by Forrest Shreve, of Johns Hopkins University and of the Carnegie Institution. Developmental and anatomical investigations have been initiated at Cinchona on the Orchidaceae, Piperaceae, Loranthaceae, Filicales and Hepaticeae by investigators from Columbia, Glasgow, Johns Hopkins and Yale Universities. Aside from the investigations accomplished, many botanists have here had their first opportunity of perceiving the intimate dependence of certain types of extreme specialization in plant structure on the accentuation of definite climatic or edaphic conditions. In other words, many have here first seen ferns and seed plants living as epiphytes, and have first appreciated the extreme diversity of habit and complexity of composition attained by the plant life of a primeval forest under tropical conditions.

Cinchona and the Surroundings

The Cinchona Station of to-day consists in the first place of the residence, a bungalow. This, with an adjoining building, can furnish



RESIDENCE, GREENHOUSES AND OFFICES AT CINCHONA. The laboratories are behind the flowering pampas grass.

RESIDENCE, GREENHOUSES AND OFFICE.

living and sleeping accommodations for eight or ten workers. There are two laboratories, each well lighted on two or three sides, that will accommodate the same number of workers, with tables, shelving, some simple glassware and a supply of plant dryers. There are two greenhouses that can be used for keeping experimental material under constant conditions, and which incidentally collect water for two large cisterns that supply the laboratories and house. The clear, absolutely pure water for drinking and cooking is brought on the head of a native carrier from the springs of the Clyde River, 500 feet below Cinchona.

The finely terraced garden about the house and laboratories is maintained in excellent condition. Despite the ravages of the hurricane of 1903, it still contains numerous fine specimens of tropical, subtropical and temperate-zone shrubs and trees. There are the native tree ferns, junipers, *Podocarpus*, orchids, bromeliads and a great *Datura* with

TWO LABORATORIES. Stables in the background.

corollas a foot long, that have been transplanted from the mountains behind Cinchona. There are fine examples of many Himalayan and Cape of Good Hope species. Large trees are here of *Cryptomeria, Cupressus Lawsoniana, Pinus Massoniana*, and two species of *Podocarpus*. The genera *Grevillea, Hakea, Callistemon, Gordonia, Pittosporum* and the beautiful *Acacia* are represented by from one to several species each. There are splendid specimens or clumps of each of a dozen species of *Eucalyptus*. Eight or ten species of subtropical palms are found here, together with *Agaves, Yuccas*, New Zealand flax with leaves

CORNER OF GARDEN. *Doryanthes Datura* and native ferns in foreground. Silk oaks and Eucalypti in background.

six feet long, and the huge Amaryllidaceous *Doryanthes*. There are clumps of beautiful *Azaleas*, whole hedges of bamboo, and thickets of two Asiatic raspberries ten feet high. On the terraces near the house are dozens of roses, *Fuchsias* with two-inch trunks, and tangled masses of deliciously scented heliotrope and *Mandevilla*, besides dozens of the more usual garden plants of temperate zones. The laboratories are nearly hidden by great clumps of pampas grass.

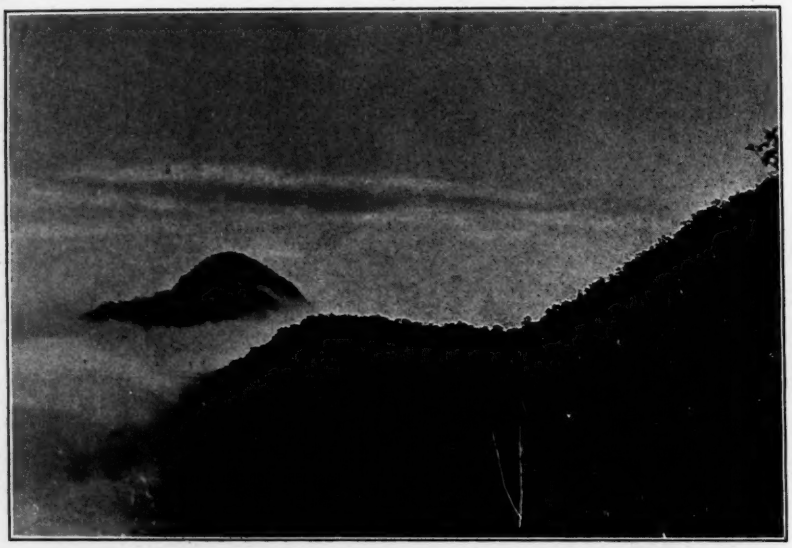
Among the flowers of the garden flit many beautiful humming birds, while up from the valleys below float the mellow, plaintive notes of a thrush—the solitaire. The garden at Cinchona, like all the surrounding region, is free from snakes and from troublesome insects. The native negro people of the Hills are courteous and obliging, and, of course, speak English.

The surroundings of Cinchona, beyond the confines of the garden, are equally interesting. Just north of the house a high knob of the spur rises a hundred feet above it. Then, after dropping 200 feet, to a saddle ten yards wide, at St. Helen's Gap, the ridge continues northward, growing wider and higher, to the Blue Mountain range itself. Southward from the house the ridge drops off abruptly, except on the southeast, so that from the terrace one may look off over the Port Royal Mountains to Kingston Harbor and Port Royal, fifteen miles away and nearly a mile below. East and west of Cinchona are the steep-sided

valleys, half a mile deep, of the Green and Yallahs Rivers, the lower slopes of which have been largely cleared and planted with coffee or vegetables. These valleys, with their changing lights and shadows, from dawn till twilight, are a constant delight to the dweller at Cinchona. In the early morning they are in deep shadow long after the sun has lighted up the mountain tops around them. A thin veil of cloud floats far down below, and, in the stillness of the morning, the faint roar of the river, coming up from the dimly seen bottom, makes the valley seem miles in depth. All day long the clouds, driven by the northeast trade winds, roll over the Blue Mountains from the cool north side and quickly melt away in the dry air above the warm southern valleys. In the afternoon the sun sets in these valleys at four or five o'clock, and their slopes cool down rapidly. Then bits of the flowing cloud break off and slowly settle down into the valley beneath, to form anew the billowy curtain that screens the valley each night. A sight long to be remembered is such a sea of cloud, reflecting from its top the glow of a sunset, or the brilliant light of the tropical moon.

During the rainy season, or "the seasons," as Jamaicans call it, the clouds become denser south of the mountains. Then Cinchona itself is enveloped in cloud most of the time for days together. I might almost say enveloped in water, for the rain is so heavy that a tumber will fill directly from the skies in three or four hours. An inch an hour may fall for hours together. The spring rainy season, of heavy rains both

CLOUD FRAGMENTS SETTLING INTO VALLEY.



A Sea of Cloud above a Valley Half a Mile Deep.

day and night, extends over two or three weeks in May or early June. A second one occurs in October. For several weeks preceding each of these rainy seasons there may be dense clouds and occasional showers at midday. From four or five o'clock in the late afternoon, till nine or ten in the morning, the sky above is cloudless. The sun sets in splendor over the western peaks and the moon and stars shine out with a sparkling brilliancy. The clear days after "the seasons" are the most beautiful of all the year. On the mountains 'round about, where all had been dark green and gray before the rains, the foliage now takes on a new brightness, and the scar-like watercourses are now veiled by white cataracts that plunge hundreds of feet down the mountainsides. Beyond the lower mountains of Guava Ridge one can see on, past the foaming surf line, out a hundred miles over the blue Caribbean.

During the late summer, and again in midwinter, the rainfall may average but three or four inches per month, and it may even be fair for weeks together, so that the soil of the hilltops and ridges about Cinchona becomes very dry. The total rainfall for the year at Cinchona is from 100 to 115 inches. North of the mountains, three miles away, there may be 200 inches in a year. The temperature at Cinchona ranges from 48 to 78 degrees, but these extremes are seldom reached. In June, 1906, while New York and Baltimore had temperatures in the upper nineties, the thermometer at Cinchona reached 72 degrees but twice, and then for but an hour or two at a time. At night, on these same days, with temperatures of 52 or 54 degrees, we were ready to enjoy the open fire of juniper logs in the living room of the bungalow.

DUCTLESS GLANDS, INTERNAL SECRETIONS AND HORMONIC EQUILIBRIUM

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IN the year 1749 there came up to Paris from the Pyrenees a young medical graduate of Montpellier who was destined to become, by reputation, at least, the most distinguished French practitioner of his time. At the age of twenty-three Théophile de Bordeu (1722–76) was already professor of anatomy at Montpellier and inspector of mineral waters at Auch and Pau; at twenty-five he had been elected a corresponding member of the Royal Academy of Sciences, and, except for an empty purse, his Parisian success was assured, not only through his handsome presence, his attractive meridional disposition and his newly acquired fashionable connections, but in part through the influence and reputation of his father, who was one of the best known Montpellier physicians of his time. In order to launch himself it was necessary for young Bordeu to pass the examinations of the Paris Faculty (his Montpellier degree counting for nothing here) and to gain the good will of its members; yet, in spite of these handicaps, he began to loom large in public consideration, when his fortunes took an unexpected turn. Bouvart, a rich and powerful practitioner of the day, became so envious that he pursued Bordeu with venomous hatred, and accused him of stealing jewels from the body of a dead patient.[1] On this charge he actually succeeded in having his name stricken from the list of Parisian physicians, and it was reinstated, after long dispute, and only through powerful influence and by two acts of Parliament. The reason for this savage manifestation of professional jealousy (the charge of theft is said to have been false) was not because the young Béarnais physician possessed any very formidable, overtopping ability, but on account of the ease with which he glided into a fashionable practice and aristocratic consideration. In an age in which the byword was "*Le ridicule tue*," his morals and his moral life were those of the courtiers of the period, and he seems to have succeeded largely through the good graces of women, one of whom, in fact, raised the money start him in practice. In his early days he had not found the rustic patients of the provinces to his liking and he aimed at a court clientèle with such success that shortly before his death he was called to the bedside of the moribund Louis XV. He himself was found dead in bed on the morn-

[1] Stealing from dead bodies was a favorite imputation against the eighteenth century doctor and is represented in an old water-color sketch of Rowlandson's.

ing of the day before Christmas, 1776, and his old enemy, Bouvart, who seems to have always kept him in mind for judicial hanging, vented his glee in an epigram which, for venom, matches up with what Louis XIV said as the cortège of la Montespan passed by in the driving sleet: *Je n'aurais pas cru qu'il fût mort horizontalement!"*

At the present time, the scientific reputation of Bordeu is of the slenderest kind. He is one of the gods of the old Montpellier faculty. In his relation to the fashionable mineral springs of the Pyrenees—Pau, Barèges, Bagnères—he seems the original, indeed, the archetypal *Badearzt.* He was a good anatomist, a piquant writer on medical history, a promoter of variolation. His view of the brain, the heart and the stomach as "the tripod of life" made its fortune in its day, and he achieved a great reputation by his revival of the complex pulse-lore or *ars sphygmica* of Galen and the Chinese physicians, a phase of eighteenth century medicine which Dr. Weir Mitchell pithily described as "observation gone minutely mad." In the history of medicine these distinctions count for very little. Bordeu, who died on the eve of the Revolution, was doubtless one of the giants before the flood, but, as compared with the great names of those who came *après le deluge*—Bichat, Louis, Laënnec, Bretonneau, Andral, Pinel, such clinical "genius" as he had acquires the ghostly implication conveyed in the original meaning of the term. It has been said that every physician of florid or fashionable reputation has in him something of the charlatan, and there are anecdotes about Bordeu which show that he was no exception to the rule. But there are one or two things which make him an important connecting link between the outmoded, pompous, pedantic French medicine of the old régime and the brilliant and truly scientific output of the Napoleonic period and after. Bordeu appears to have been the first anatomist to employ the term "tissue," and his "Recherches sur le tissu muqueux ou l'organe cellulaire" (1767) immediately suggest the great Bichat, whom he influenced, it is true, but in a most untoward way. By *tissu muqueux,* which he also calls *l'organe cellulaire,* Bordeu means neither cellular structures as Schleiden and Schwann saw them nor protoplasm as Purkinje and Schultze saw it, but simply such vague protoplasmic configurations as were visible through a lower-power microscope. It was his ambition to confirm and uphold the humoral pathology of Hippocrates, and he regarded the three Hippocratic stages of disease, irritation, coction and crisis, as dependent upon the glandular and other secretions. Corresponding with the different organs and secretions, he classified diseases, not according to their clinical or pathological manifestations, but arbitrarily as cachexias, of which he devised a prodigious list, *e, g.,* bilious, mucous, albuminous, fatty, splenic, seminal, urinary, stercoral, perspiratory; with an equally complex classification of the pulse as critical, non-critical, nasal, tracheal,

gastric, renal, uterine, seminal, etc. All this undoubtedly influenced Bichat in the fundamental error of his scientific work, viz., the ascription of specific vital property to each classifiable tissue. Bordeu's slender reputation to-day is concentered in a single idea—the doctrine that not only each gland, but each organ of the body, is the workshop of specific substance or secretion which passes into the blood, and that upon these secretions the physiological integration of the body, as a whole, depends. This doctrine is contained in his "Analyse medicinale du sang" (1776), the importance of which has been signalized by the eminent medical historian, Professor Max Neuburger, of Vienna.[2] An examination of this work will hardly realize the expectations which are raised by Professor Neuburger's panegyric. It is a typical example of the purely theoretical reasoning so common in the medical literature of the eighteenth century, in which an intolerable deal of verbiage is spread over the smallest substructure of fact. Cases are frequently cited but they are not true clinical delineations, only gossipy personal anecdotes, not unlike those of Brantôme. A great deal is said about the sexual side of man, and indeed the most interesting part of Bordeu's theory is his observation of the effects of the testicular and ovarian secretions upon the organism. He regarded the sexual secretions as giving "a male (or female) tonality" to the organism, "setting the seal upon the animalism of the individual," and as a special stimulus to the human machine (*novum quoddam impetum faciens*). He described in detail, the secondary sexual changes, not only in eunuchs and capons, but also in spayed animals of the female sex. In connecting all this with specific secretions, discharged, not externally, but into the blood, Bordeu was, as Neuburger rightly contends, very close upon the modern theory of the internal secretions, but, as he made no experiments, his ideas can only be regarded as an interesting phase of eighteenth-century theorizing. Aside from Bordeu's deduction from what he saw, almost any stock-raiser or poultry-fancier might have noted the same facts, and facts of equal moment had been noticed long before his time.

To begin with, one of the oldest therapeutic notions is the idea that such unsavory materials as the viscera or excreta of animals, administered either singly or as a maximum compositum might avail in the treatment of disease. This mode of therapy was a common feature of the Egyptian medical papyri, was known to the Greeks and Romans, made great headway during the dark ages, and reached its height in the seventeenth century. The four London Pharmacopœias of 1618, 1650, 1677 and 1721 abound with such remedies as the bile, blood, bones, brains, claws, eggs, excrement, eyes, fat, feathers, hearts, horns, intestines, marrow, milk, omentum, placenta, rennet, sexual organs, skin, teeth and urine of all manner of animals; also bee-glue, civet, cock's comb, coral, crayfish,

[2] Neuburger, *Wien klin. Wochenschr.*, 1911, XXIV., 1367.

earthworms, pearls, perspiration, saliva of a fasting man, scorpions, raw silk, silkworm's cocoons, moss from the skull of a man who has met a violent death, spermaceti, sponge, spider webs, cast off snake's skin, sea shells, swallows' nests, suet, viper's flesh, wax and woodlice; and along with these went those relics of the old Arabian polypharmacy, the theriacs and mithridates, which consisted of grand mixtures of anything and everything in the way of vegetable simples. In the seventeenth century there were actually "filth-pharmacopœias" (*Dreck-Apotheken*). The only physician of the time who did not attach much importance to these remedies was the one who had the greatest fund of practical sense, Thomas Sydenham. In the pharmacopœias of 1721 and 1746, these nauseating remedies begin to disappear. One year before the latter date, William Heberden, who was probably the greatest English clinician between Sydenham and Bright, published his satirical pamphlet "Antitheriaka" (1745), which was, in effect, a critical onslaught on polypharmacy. Charles Lever tells of a certain individual who was "laughed out of Ireland." Heberden banished the theriacs and mithridates from medicine with the scholar's ironical smile, and with them went the filthier features of the materia medica. As a result of this cool douche of common sense, the Pharmacopœia of 1788 retains but a single animal remedy—woodlice. Yet these things were the crude elements of the present theory of treating certain diseases by means of animal extracts. Before the time of Brown-Séquard, the only animal extracts in our present pharmacopœia were the antispasmodics, musk and castoreum, which used to be described to gaping students, receiving their first instruction in the action of drugs upon the human frame, as derivatives of the preputial gland and follicles of the Tibetan musk deer and the beaver, respectively.

Another set of observations which bears upon our subject is that connected with the universal interest in giants and dwarfs, the acromegalics and achondroplasics of modern pathology. The acromegalic giants go back to the legendary lore of the Nephelim in Genesis (VI. 4), of Og, king of Bashan, the Anakim, Goliath of Gath, the Titans, Antæus, Polyphemus, Fafner and Fasolt, Gog and Magog, down to the huge images of Manchuria, the innumerable reports of excavations of giant skeletal remains and the Irish, Chinese and Russian giants of more recent date. The achondroplasic dwarfs suggest the short-limbed satyrs, the dwarf gods of Egypt (Bes, Phtah and others),[3] the black pygmy races,[4] the court dwarfs and buffoons figured by Velasquez and

[3] For a full account of these, with many illustrations, see the Munich dissertation of Franz Ballod: "Prolegomena zur Geschichte der zwerghaften Götter in Aegypten" (Moscow, 1913).

[4] There are no white races of pygmies, and it is probable that most white dwarfs are myxœdematous or achondroplasic.

other great painters, and the athletic, acrobatic and humoristic dwarfs of our vaudeville shows.

Among the ancient Romans, it was customary to test the increase in the girth of a young woman's neck, in connection with defloration or pregnancy, by measurement with a thread, as indicated in the lines of Catullus:

> Non illam nutrix oriente luce revisens
> Hesterno collum poterit circumdare filo,

but there is no evidence that they associated this cervical enlargement with the thyroid gland. Endemic goiter, however, was so well known in antiquity that Juvenal (XIII., 162) has preserved its commonplace aspects in a single line: "*Quis tumidum guttur miratus in Alpibus*" ("Who wonders at goiter in the Alps?"); and Pliny, in his Natural History (XI. 68), hinted at one theory of its causation when he said that "only men and swine are subject to swellings in the throat, which are mostly caused by the noxious quality of the water they drink." In the sixteenth century Paracelsus found goiter to be endemic in the Salzburg region, again attributed it to metallic and mineral constituents in the water, and noticed that it coexisted with another disease of the same locality, cretinism or myxœdema. While goiter is not a necessary characteristic of idiots (*proprium stultorum*), says Paracelsus, yet it is most commonly found among them (*so trifft es die am meisten*)[5] after which, he wanders off into his usual astrological theories, in which few can follow him. The important point is that in goitrous regions, as Dock says, cretins may have goitrous mothers while the marriage of two cretins is usually sterile,[6] which makes the observation of Paracelsus fit in very well with his main theory of the provenance of idiots (*generatio stultorum*).

In 1614 Felix Plater, another Swiss physician, published an observation which seems truly modern, an autopsy of an infant who had died from enlargement of the thymus gland ("thymus-death").[7]

As we begin to perceive the relation of these varied phenomena to the glands of internal secretion, it will not seem strange that Bordeu, who first stated the modern theory, should have hit upon the sexual gonads as the most obvious illustration, for nearly all these glands are in some way connected with the sexual characteristics of the individual. We may now pass from the stage of hap-hazard observations to that in which certain diseases were closely and accurately described, like objects in natural history, and it is worthwhile to range these in chrono-

[5] Paracelsus, "De generatione stultorum" (in his "Opera," Strassburg, 1603, pt. 2, p. 177.

[6] George Dock on "Cretinism" in Osler's "Modern Medicine," Philadelphia, 1909, VI., 448.

[7] Plater, "Observationum in hominibus affectibus . . .," libri III., Basel, 1614, 172. Cited by Friedleben.

logical order, as illustrating the slow growth of a certain phase of inductive science.

II

On the continent of Europe, the disease "exophthalmic goiter" is variously known as "Basedow's disease," or *morbo di Flajani,* after the two observers who in Germany and Italy are thought to have originally described it. Basedow, a physician of Merseburg, published, in 1840, a description so complete that the Germans regard it as the classical one. The three symptoms which he signalized—swelling of the thyroid gland, protrusion of the eyeball and palpitation of the heart—the Germans sometimes call the "Merseburg triad,"[8] which they also designate by the simple telegraphic epithet "Basedow." Among English-speaking people, exophthalmic goiter is usually known as Graves's disease, after the well-known Irish clinician who printed an accurate account of it in 1835. But more than fifty years before Basedow, Caleb Hillier Parry, an eminent physician of Bath, England, made a notation of all phases of the Merseburg triad, part of which deserves citation, if only on account of its historic interest.

Enlargement of the thyroid gland in connection with enlargement or palpitation of the heart.—The first case of this coincidence which I witnessed was that of Grace B., a married woman, aged thirty-seven, in the month of August, 1786. Six years before this period she caught cold in lying-in, and for a month suffered under a very acute rheumatic fever; subsequently to which she became subject to more or less of palpitation of the heart, very much augmented by bodily exercise, and gradually increasing in force and frequence till my attendance, when it was so vehement, that each systole of the heart shook the whole thorax. Her pulse was 156 in a minute, very full and hard, alike in both wrists, irregular as to strength, and intermitting at least once in six beats. She had no cough, tendency to fainting or blueness of the skin, but had twice or thrice been seized in the night with a sense of constriction and difficulty of breathing, which was attended with a spitting of blood. She described herself also as having frequent and violent stitches of pain about the lower part of the sternum.

About three months after lying-in, while she was suckling her child, a lump of about the size of a walnut was perceived on the right side of her neck. This continued to enlarge till the period of my attendance, when it occupied both sides of her neck, so as to have reached an enormous size, projecting forwards before the margin of the lower jaw. The part swelled was the thyroid gland. The carotid arteries on each side were greatly distended; the eyes were protruded from their sockets, and the countenance exhibited an appearance of agitation and distress, especially on any muscular exertion which I have rarely seen equalled. She suffered no pain in her head, but was frequently affected with giddiness. [After outlining his scheme of treatment, Parry concludes:] From this time no further application was made to me respecting this patient, who probably soon paid her debt to nature.

Between 1786 and 1815, Parry collected eight cases of this malady, which were published after his death, in 1825.[9] He undoubtedly is en-

[8] Basedow, *Wochenschr. f. d. ges. Heilk.*, Berlin, 1840, VI., 197: 220.

[9] Parry, "Collective Writings," London, 1825, II., 111.

titled to the credit of the original and classical account of the disease, although he did not, as the French say, *afficher,* that is advertise, his discovery by attempting to label it.

In 1833, Flajani published his account of the disease, in which he recognized two of the cardinal symptoms, the goiter and the cardiac palpitation. In discussing palpitation of the heart at the Meath Hospital in 1835, Robert Graves, the Dublin clinician, published his classical description of exophthalmic goiter, in which the exophthalmic feature was noted. He records that, in one patient, the beating of the heart could be heard at least four feet from her chest. After the time of Graves and Basedow, many similar observations were collected by clinicians, but it was not until the year 1886 that the condition was attributed to an excessive outpouring of the thyroidal secretion by the German neurologist. Möbius,[10] who at the same time, described a number of related symptom-groups which he regarded as due to qualitative or quantitative changes in the secretion itself ("dysthyroidism"). In connection with the cretins observed by Paracelsus around Salzburg, it is of record that Curling, an English pathologist, first observed that absence of the thyroid body is accompanied by "symmetrical swellings of fat tissue at the sides of the neck, connected with defective cerebral development" (1850). The classical account of this condition is due to Sir William Gull (1873) and it was called myxœdema by William M. Ord, of London, in 1877.

It is a curious fact that the same volume of the journal in which Basedow published his account of exophthalmic goiter contains an observation by Benhard Mohr,[11] a privat docent at Würtzburg, of a remarkable and fatal obesity in an elderly gardener's wife, attended by incipient imbecility (*läppisches und kindisches Benehmen*), loss of memory, general somnolence and scotoma, which, coming to autopsy, revealed a tumor-like degeneration of the pituitary body produced by inmixture and copious effusion of a serous fluid, the discharge of which had induced pressure phenomena in reference to the adjacent parts of the brain. This was the first recorded case of what is now known as pituitary obesity (1840), the "dystrophia adiposo-genitalis" of Fröhlich and Bartels.

In spite of the amount of original clinical delineation already on record in the first half of the nineteenth century, these lesions of the ductless glands attracted little attention. More interest was excited by the appearance, in 1855, of what we must now regard as the principal milestone in the history of the subject, the monograph "On the Constitutional and Local Effects of Disease of the Supra-renal Capsules," a quarto of 43 pages by Thomas Addison, senior physicion to Guy's

[10] Möbius, *Schmidt's Jahrb.,* Leipzig, 1886, CCX., 237.

[11] Mohr, *Wochenschr. f. d. ges. Heilk.,* Berlin, 1840, VI., 565–571.

Hospital, London. In the history of medicine, this work was destined to have an immortality of its own. In the very opening lines of his preface, Addison clearly states, for the first time, the true paths by which, as subsequent experience has proved, the problems of these mysterious glandular structures have been best approached and attacked:

> If Pathology be to disease what Physiology is to health, it appears reasonable to conclude, that in any given structure or organ, the laws of the former will be as fixed and significant as those of the latter; and that the peculiar characters of any structure or organ may be as certainly recognized in the phenomena of disease as in the phenomena of health. When investigating the pathology of the lungs I was led, by the results of inflammation affecting the lung-tissue, to infer, contrary to general belief, that the lining of the air-cells was not identical and continuous with that of the bronchi; and microscopic investigation has since demonstrated in a very striking manner the correctness of that inference—an inference, be it observed, drawn entirely from the indications furnished by pathology. Although pathology, therefore, as a branch of medical science, is necessarily founded on physiology, questions may nevertheless arise regarding the true character of a structure or organ, to which occasionally the pathologist may be able to return a more satisfactory and decisive reply than the physiologist—these two branches of medical knowledge being thus found mutually to advance and illustrate each other. Indeed, as regards the functions of individual organs, the mutual aids of these two branches of knowledge are probably much more nearly balanced than many may be disposed to admit; for in estimating them, we are very apt to forget how large an amount of our present physiological knowledge, respecting the functions of these organs, has been the immediate result of casual observations made on the effects of disease. Most of the important organs of the body, however, are so amenable to direct observation and experiment, that in respect to them the modern physiologist may fairly lay claim to a large preponderance of importance, not only in establishing the solid foundation, but in raising and greatly strengthening the superstructure of a rational pathology.

Thus did Addison set forth the fact that Nature herself is sometimes the physiologist's best vivisector, even as Billroth and the followers of Marion Sims elucidated the pathology of the abdominal and pelvic viscera by making "autopsies *in vivo*."

On March 15, 1849, Addison read a paper before the South London Medical Society[12] in which he described the symptoms of what is now styled pernicious anæmia, cases in which the whole surface of the body "bear some resemblance to a bad wax figure." Only three of the cases came to autopsy, but "*in all of them was found a diseased condition of the supra-renal capsules.*" Was this a mere coincidence? Addison inquires.

> Making every allowance for the bias and prejudice inseparable from the hope or vanity of an original discovery, he confessed he felt it very difficult to be persuaded that it was so. On the contrary, he could not help entertaining a very strong impression that these hitherto mysterious bodies—the supra-renal capsules—may be either directly or indirectly concerned in sanguification; and that a diseased condition of them, functional or structural, may interfere with

[12] Addison, *London Med. Gaz.*, 1849, XLIII., 517.

the proper elaboration of the body generally, or of the red particles more especially. . . . Indeed, not only had he found the anæmia in question occasionally occurring in connection with purpura, but had observed in cases of the latter disorder certain local symptoms which pointed somewhat significantly to the supra-renal capsules; whilst the bloodless and waxy appearance of certain chlorotic females bore so close a resemblance to the anæmia described, that it was difficult not to suspect the existence of something common to both.

In his monograph of 1855, after referring to "an ill-defined impression" that the suprarenals, in common with the spleen, thymus and thyroid body, "in some way or other minister to the elaboration of the blood," and after a modest reference to the "curious facts" upon which he had "stumbled," Addison proceeds to develop the symptoms of what is now called Addison's disease—anæmia, general langor and debility, feeble heart action, irritable stomach, with a dingy or smoky discoloration of the whole surface of the body, sometimes reaching a deep amber or chestnut brown—and elucidates its pathology in eleven cases, accompanied by striking and life-like colored plates. From these records, it appears that the earliest known case of Addison's disease was reported by his great colleague at Guy's, Richard Bright (of Bright's disease) in 1829. In another, reported by Addison himself, the post-mortem section was furnished "by my distinguished friend Dr. Hodgkin" (of Hodgkin's disease). While developing his subject with the firm hand of the master in descriptive pathology, Addison draws no such striking conclusions in this memoir as we find in his paper of 1849 or as are indicated in the preface to the memoir itself. He does, however, draw attention to the important fact that even malignant disease may exist in both capsules without giving rise to the Addisonian discoloration of the skin. It was this memoir which led Brown-Séquard to reproduce the fatal disease experimentally by excising the suprarenal capsules in animals. The pouring out of the thyroidal and adrenal secretions during surgical shock or under the passion of fear (psychic shock) was emphasized long after by Crile and W. B. Cannon.

There remains one other affection which, on account of its present importance, may be briefly considered before passing to the experimental phases of the subject. The disease of acromegaly or gigantism was, as we have said, regarded as an abnormity from the days of Goliath of Gath up to the time of John Hunter's famous and expensive chase after the skeleton of the Irish giant (1783), but even before this definite cases had been reported, with good accounts of the deformities of the bones and the periodic coma, by Saucerotte (1772) and Noël (1779), and in the nineteenth century by Alibert (1822), Chalk (1857), by Friedreich in the case of the two Hagner brothers (1868), by Lombroso (1868), and by Sir Samuel Wilks, who in 1869 made a striking notation of the disease. The accepted classical account is that of

Charcot's pupil, Pierre Marie, who differentiated the affection from myxœdema, osteitis deformans and leantiasis ossea, gave it its present name and, four years later, correlated it with disease of the pituitary body.[13] Marie's claims to priority are somewhat vitiated by the fact that a lesion of the pituitary body in acromegaly had already been noted by Verga (1864), Brigidi (1877) and more particularly in the superb autopsy made by the late Edwin Klebs in 1884, which is the work of a veteran pathologist. This monograph,[14] based upon a case furnished by Dr. Fritsche, of Glarus, Switzerland, contains two striking views of the patient and a remarkable diagram of the acromegalic skull; the hypertrophy of the pituitary body and the consequent widening of the sella turcica is strongly emphasized. But the opinion of the eminent pathologist is divided between this lesion and a proliferation of the thymus gland, which he found in the same autopsy, and after balancing the claims of the two lesions at length, he winds up by declaring that the cause of the disease must remain obscure. The view of Marie, which connects it directly with a lesion of the pituitary body,[15] has been, with some reservations, the theory accepted up to the present hour. It is interesting to note that, from the time of Galen up to the seventeenth century, the pituitary body was held to be the source of the mucous discharges of the nose. Vesalius, for this reason, called it the "*glans pituitam excipiens.*" This idea was overthrown in Conrad Victor Schneider's treatise on the membranes of the nose ("Decatarrhis," 1660) and by Richard Lower in 1672. Théophile de Bordeu, in his anatomical researches, states that the ancients thought the office of the pituitary body was to empty its humors through the nostrils, the moderns holding that it sent them to the sinuses of the sella turcica, and there the matter ends with him, although he indulges a few vague conjectures as to the possibility of the passage of the pituitary secretions into the circulation.

(*To be continued*)

[13] Marie, *Rev. de méd.*, Paris, 1886, VI., 297–333, and in the graduating dissertation of his pupil, Souza Leite (Paris, 1890).

[14] Fritsche and Klebs, "Ein Beitrag zur Pathologie des Riesenwuchses," Leipzig, 1884.

[15] For an interesting account of this disease, see "Acromegaly, A Personal Experience" (London, 1912), by Dr. Leonard Portal Mark, a practising physician who has given a graphic and pathetic description of the gradual onset of the distressing malady in his own body. Although his disease was privately diagnosed by most of his clinical associates and he was "spotted" as an acromegalic in a Parisian crowd by Marie himself, Dr. Mark did not begin to realize his condition until he was fifty.

A NEW PHASE OF AN OLD CONFLICT

By LAUNCELOT W. ANDREWS
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WHEN those among us were young, upon whom time has now placed his silver stamp, the intellectual atmosphere was trembling with the noise of a conflict in the clouds. It was called "The Warfare of Science and Religion." The dragon's teeth from which this warfare sprang were sown with the first steps in organizing human society.

The social order is a machine and, like every machine, consists of two functionally distinct elements, the static and the dynamic. In the machine, the static element is the framework which correlates the other parts and maintains stability, while the dynamic part is made up of the moving parts which confer the capacity for change and, hence for work. The static or conservative element in the social order is that body of ethical or moral ideas and traditions which we denominate religion, while the dynamic element is the summation of man's experience with nature, of his knowledge of phenomena, of his technical information, of his objective social history, things which, taken together, we call science.

From the earliest beginnings of science, onward, the scientists have been the pioneers of society and have exhibited the characteristics of pioneers, in their keen interest in the new, in their disregard of the old, in their readiness to risk goods already in hand for better goods dimly seen on the horizon, and their disesteem of tradition. One can easily imagine that if the parts of a machine were conscious the moving members would look upon the stationary stability of the frame with a certain contempt and, resenting its restraint, might even regard it as a thing superfluous, as an obstacle in the way of free movement. This has often been the attitude of men of science.

The religionists, on the other hand, conscious of their conservative function, must regard themselves as the responsible custodians of an inheritance threatened by every change and by every disturbance of the social order, and must, on principle, oppose a new thing until it has proved its value; by which time it is of course no longer new. So we find, the scientist always trying to induce the people to do something they have never done before, while the religionists are urging them to keep out of danger and to return to a model of the past, that is, to imitate the example set by the founders of the several sects.

From this point of view there must always be a conflict between science and religion, but a conflict only in the sense of an action and

reaction, a mutual pressure exerted by each upon the other. Religion is the fulcrum and science the lever which together raise mankind.

Recent debate on these matters is marked by a great improvement in tone as contrasted with that prevalent thirty or forty years ago. Not only is the spirit of the controversy altered, but its ground has shifted. Both parties have changed their positions. The religious partisans no longer dispute the verdict of the scientists in scientific things and many scientific men have abandoned the position that "matter holds the promise and potency" of everything in the universe, and now assign this "promise and potency" to energy, regarding matter merely as a symbol of thought.

Now the concept of energy is a good deal more closely related to that of spirit than is the concept of matter, so that it has become easy for the scientific men so to extend the bounds of their own field as to claim all that which was formerly regarded as the exclusive domain of religion. To make this new position clear, I might attempt to give a bird's-eye view of the utterances of several recent scientific writers, to construct a composite picture, so to speak. But to do this briefly would be impossible, so that I have perforce elected a different procedure, namely, to present in outline the views of a single author, selected as highly typical of the modern drift of thought along these lines. The writer chosen for this purpose is Wilhelm Ostwald, formerly, for many years, professor at the University of Leipzig, distinguished as a scientific man and now editor of the *Annalen der Naturphilosophie.*

In what follows, it shall be my aim to lay before you a brief summary of the position taken by Ostwald on the relations of science to religion, in a manner as devoid as possible of any color reflected from my own views. With this object, I shall not break into the presentation by any comment or criticism, and shall follow Ostwald's own phraseology so far as may be compatible with necessary condensations and omissions.

Self-respect and happiness are, in the last analysis, the motives of human conduct in those things that lie beyond mere maintenance of existence. In fact, the greatest happiness which can come to a man in advancing years is to diffuse happiness about him by the production of creative ideas which relieve mankind of heavy burdens and increase the general opportunities for happiness. The creative ideas which bring happiness most directly are, in the first line, those furnished by science, in so much as science lessens or removes many forms of disease and misery which plague or threaten man in consequence of his biological relationships. What no one of the many religions has been able to do has been accomplished, in an ever-increasing degree, in bettering those conditions of life which make for happiness, not alone through the advance of medical knowledge in the treatment of disease, but still more in teaching man how to minimize the causes of disease. The surprising

extension of the span of human life, within a few decades, is an index of what has already been attained in this direction.

The fact that any one, to-day, can buy at small cost works of the best thinkers and poets, and excellent reproductions of works of art, is a witness to how much richer, not only our external, but also our inner lives have become, through technical achievements that rest absolutely on scientific progress. So, a fruitful stream, bearing all manner of opportunities for intellectual and esthetic culture, flows among the people.

Yet more deeply does science now influence the spiritual life of man. Self-respect[1] has already been alluded to as holding first place among the conditions that make for happiness. No religion can impart this highest good of mankind, this deep harmony which can withstand all vicissitudes of life. This results from the circumstance that every religion is impelled to construct a fixed and permanent standard for all believers out of the mode of thought of its founder. Now the founder must have been able to raise himself far above the level of his contemporaries in order to become such a founder. But it is no less true that he must have stood on the foundation which his time furnished, otherwise he could have had no profound influence over his own age. Herein lies a necessary limitation.

Again, to science we owe our recognition of the evolution of the human species and of its continued foregoing to higher and higher planes of thought and feeling. This recognition involves the corollary that every religion, in proportion as it becomes older, is brought into ever greater contradiction with the science of the present.

Protestantism is nothing else than a four-century effort to accommodate the content of the christian religion to the time, more fully than was possible with the Romish church. This form of religion succeeded, accordingly, for several hundred years in meeting the needs of the masses, but not so completely those of more advanced religious thinkers. Here again the tendency to become outgrown, which is inherent in every religion, became irresistible, and a sense of the conflict disturbed the conscience, alike of the most spiritually minded and of the multitude.

In contrast with this inevitable, inexpugnable, drift toward senescence of all religions, science shows itself of another character, as being eternally young. Since with her no condition, no cognition, is ever regarded as final or unalterable, and since by her all things are subjected to a ceaseless, conscientious criticism, errors may indeed occur, but they can not become firmly fixed. "Inner self-respect," the unshakable determination to tolerate no internal contradiction, is her life's element and the condition of her existence, hence she must, as against death, defend herself against every attempt to limit the right of criti-

[1] The word "self respect" is here used to designate a freedom from all conflict between the thinking and the doing, between "I will" and "I must."

cism, that is, of scientific investigation of anything whatsoever, under the obligation of absolute sincerity. None will deny that science has not always been conceived in this high sense, but the religions have fallen still further short of their standards, because they have not contained the source of self-betterment, which science possesses in the principle of free criticism.

It is of interest to enquire how it comes that most religions place the paradise or golden age in the past, and teach that man has become worse through sin, while science teaches that savagery, cruelty, bloodthirstiness, murder and cannibalism are greater as we go backward in the history of mankind, and points to the future, not to the past, as the golden age. How does it happen that the opposite view has been so general? The answer is to be found in the attitude of the aged toward the time of their own youth. The old, almost without exception, think that the period when they were young was better, the weather more brilliant, the apples more tasty, the bread their mothers made finer, and the boys more industrious than is the case now. This is not difficult to account for on the ground of the impairment of the keenness of all organs of sense and the enhanced habit of criticism which age brings.

The early writers, who presented views on the topics in question, were naturally old men, for the young have but little inclination for such activities. It comes, then, that the attitude of the aged, tinged as it is by the limitations of age, has very often been accepted as representing a historic fact with regard to the past. Ancient literature is permeated with this myth. The influence of it on the religions of the world has been potent. Admitting that the world has become worse, a necessity is felt to account for the supposed fact by assuming the existence of a personal evil agency, to whom was due the introduction of evil. There is in the religions, accordingly, a marked note of pessimism.

The natural world is entirely filled with cruelty, roughness. It is the theater of the wildest selfishness, in which the balance between the beings who people it is preserved only by their devouring and destroying one another. In it only the battle for existence, so well described by Darwin, rules. Man is the sole being we know in nature which makes himself more and more free from the tyranny of this conflict and provides for existence by peaceable work. He alone seeks to heal the sick and to aid the feeble. The results of the good which he does are not restricted to himself and to the recipient, since, as a result of a known biological law, every time such conduct is practised the easier it becomes, not to the individual only, but to all his descendants. That man is most *man* who most consistently practises love and kindness in a world of egoism.

In early times, when mere existence was so hard a task that progress could scarcely be thought of, religion with its fundamental principle of *stability* was the most advantageous form of culture. Later, when the

more primitive substructure of civilization had been secured by the fixative power of religion, conflict arose between the practical requirement of self-preservation, on the one hand, and, on the other, the distinctively human thirst for betterment and progress. Furthermore, those classes or individuals which enjoy special privileges or advantages turn to the church as the preserver of the *status quo*. In fact, the church can so act, but only temporarily, until the disproportion between reward and merit has become so glaring that the unprivileged classes will endure it no longer. Retardation of progress leads to revolution. To that extent the church is as naturally the source of revolutions as science is of peaceful development. The church is unable to prevent progress, but can and does suppress the symptoms of progress. This is tantamount to screwing down the safety valve on a steam engine and hiding the steam gauge.

Recent history affords many instances in Roman catholic lands. It is noteworthy that in the protestant countries of northern Europe, the monarchy remains unthreatened, whereas in most of the catholic lands republics have, by revolutionary methods, supplanted the monarchs, Recently in Norway, as the free choice between monarchy and republic was presented to the people, they chose the former.

The foregoing considerations make clear a certain relation between science and religion. The further we go back in civilization, the more valuable we find religion to be. The further we rise in it, the more does religion retire into the background, giving place to science.

Can religion ever become superfluous?

Ostwald's answer to this query is, that one stratum of the people after another raises itself out of the ocean of religious conceptions, and that the movement toward the superfluity of religions is a gradual one, of which it is impossible to predict the date of completion, inasmuch as considerable portions of the human race are on so low a level of cultural capacity as to make it doubtful whether they will ever reach the highest plane. These will surely have a need for religions and will cherish them. In this sense are to be understood the words of Goethe:

> He who has science and art
> Has religion also,
> He who has neither of these,
> Let him have religion.

All religions maintain that the contents of their scripts and tenets constitute the truth, and that no mere human or mundane knowledge can claim this designation, since it is, at best, artificial and confessedly imperfect. On the other hand, the various religions contradict one another, each claiming for itself absolute truth as its exclusive possession in many and important points. Hence follows the conclusion that the claims of the several religions to the possession of the absolute truth neutralize one another and become invalid.

Again, we must turn to human knowledge, and ask whether *it* can lead us to the truth or near to it. Here we find the picture reversed. Whereas, the religious conceptions claiming the truth for their own, separate in course of time further and further from one another (witness the splitting of the christian church into three great branches, catholic, Roman catholic and protestant, and the further schism into innumerable sects) so, on the other side, the laws and concepts which science accepts as true come, in course of time, ever closer together. The rotation of the earth about the sun, stigmatized as false by the dominant religion, was not on that account abandoned by science as a truth. Historically speaking, science has always maintained its stand, while it has ever been the church which yielded to the decision of science, sometimes after long waiting. The most orthodox priest would not now venture to deny the Copernican theory, and would not be seriously taken by his followers if he did.

It can not be otherwise than that science should gradually supersede the religions, when it comes to investigating the truth, for it lies in the nature of the influence exerted by science on the aspect of life. The religions must drop their old concepts in proportion to the measure in which the spirit of science permeates the people.

When man made his first attempt at comprehension of the chaos of the world, the sum of such thoughts, constituting the germs of that which we now call poetry, science, religion, technology, was all put in one basket. The early bearers of the torch of culture were priests, doctors, rulers, judges, all in one. That was quite possible, since the sum total of intellectual possessions was not very great and might find commodious lodgment in a single head. With growing specialization, some of these functions were of necessity delegated to certain classes. The position of first comer and the prestige of tradition long enabled the priesthood to still reserve to itself the functions of government.

The source of the conflict between science and religion lies in the fact that science takes part in the development of the human species and is, herself, the most distinctive and purest expression of this development, while the religions seek to remain as unchanged as possible, although in doing so they condemn themselves to destruction. In consequence of the illusion which always located the golden age in the past, the priesthood never surmised that their attitude was equivalent to suicide, and emphasized just that which must ultimately make their position untenable. When the contrast between the old, cherished by the priesthood, and the new, which life brings, becomes too obvious, the phenomenon known as a "Reformation" follows, as, for example, the reformation of Judaism by Jesus and of Christendom by Luther and Calvin. The only reason why no similar reformation has occured in protestantism is that science has gained such an influence, even within

the church, that the latter has accepted progress as a practical principle. So, protestantism advances along the path where science has led the way—at a variable distance. At present, in the whole protestant church, science is recognized as the court of last resort. The church no longer undertakes to say what shall be valid in science, *i. e.*, what shall be true, but, on the contrary, endeavors to keep its doctrines in harmony with the established results of science, or, at least, seeks to show that no disharmony exists.

The root of the irresistible power of science lies therein, that she is, in fact, in possession of the truth. Certainly not of *all* truth, and still less of the absolute truth: but, all the truth which exists in our world is in the possession of science. This possession can never grow less, but is bound to increase.

What is truth? To this question Ostwald replies: Truth is that which makes possible prediction of the future. If a man says he fell down yesterday while alone, it is impossible to determine the truth of the statement, and his story must forever remain in that uncertain limbo where the distinction between true and false is lacking. If, however, he says: "To-morrow I shall go to Chicago," it is perfectly feasible to test the truth of the affirmation by observing the man on the following day.

The lesson taught by the illustration is a general one. In strictness, truth exists only as regards the future, since only in the future can we exercise trustworthy control. Although as to the past we have many witnesses and traces, nevertheless, our conclusion from them has only the character of a probability, and floats somewhere between truth and falsehood, although at times very near the former. The truth of an allegation with regard to the future can, in general, be positively settled. Moreover, we have no interest in the past as such, since we can not change it for better or worse. We can change the future, and it only. Hence, we call that truth which enables us to have a sure influence on the future. Many cases indeed exist where we wish to know the truth about the past, but such truth interests us only in so far as it enables us to exert a defined influence on the future. Whether snow fell on February 3, 1325, on the spot where my house now stands has for me no importance, because for me nothing depends upon it. But if I had information of the qualities of my ancestors for several generations back, it *would* interest me, for the reason that it would give me knowledge of my own mental and moral make-up and assist my self-culture. Self-culture is, however, equivalent to a regulation of my conduct in the future.

All our fellow-men are able to predict the future more or less, in the measure that they possess science. When the domestic lights a fire in the stove of a winter morning she goes through a series of manipulations, which of themselves produce no heat, on the sure prediction that her labors in carrying coal, chopping kindling and striking a match will

result in a warm room. When an ocean steamer is to be built at a cost of $15,000,000, the capitalists risk that sum on the prediction of the engineers that if such and such be done, a steamer of well-defined capacities will be the outcome.

We are already in possession of so great a body of truth that no man can know one-hundredth part of that which mankind as a whole has. On looking over the field of what science has accomplished for the amelioration of human life, we are impelled to ask: "How has science solved such problems and conferred such benefits?" Science is the systematized knowledge of the human race. The science which deserves the name is a knowledge of the future. How do we arrive at this knowledge of the future? The answer is familiar.

Science has at her disposal a great number of so-called "laws," that is, knowledge of the interdependence of occurrences. If we know that whenever *A* happens, *B* will follow, we have gained two things. If *A* occurs without act of ours, we can predict the coming of *B* and so arrange our lives that *B* will be as advantageous as possible for us, or as little injurious. On the other hand, if we can influence the coming of *A*, we will avoid *A* when *B* is undesirable, or produce *A* in the reverse case. Science, then, works in two ways. By its help we can prepare ourselves for the future or we can prepare the future for ourselves. Neither of these things is done by man exclusively. All living things have the rudiments of the capacity to see into the future, and even to adapt it to their needs, as, for example, in the case of a certain wasp, which buries along with each egg hidden in the soil, a freshly killed insect, so that the larva may find food at hand. Such primitive forms of conduct directed toward the future do not constitute science; in so much as they are not purposive nor conscious. It is necessary merely to allude to these instinctive acts upon which the existence of a species depends, in order to bring clearly to the understanding the vital importance of science to mankind.

In ancient times work was looked upon as highly undesirable. As a heavy punishment for disobedience regarding the tree of knowledge, the primal curse was imposed: In the sweat of thy brow shalt thou earn thy daily bread. Civilized man has arrived at an attitude toward work quite different from this. To him, a life devoid of labor appears empty and shallow. Those who would wish such a life he regards as contemporaries of minor worth. His high aspirations turn, not toward a state free from labor, but, rather to one in which he may enjoy the happiness of choosing the object of his work and its kind.

Even modern conquerors and despots, that is, those collectors and possessors of giant capital, who in our time are the greatest world-power, are infected with the modern need and impulse to work and, however questionable (or unquestionable) their morals may in other respects be,

most of them wear themselves out more in acquiring the source of their dominion than the humblest of their dependents, and for the most part do not cease to strain their mental capacities to the limit in this exacting labor, long after they have amassed fortunes far beyond the most exaggerated possible requirements of the individual.

We perceive that for the man of to-day work has become an instinctive need. We find it difficult to understand the biblical presentation of it as a curse. Herein we have an illustration of a phenomenon of moment to living beings which can be summarized thus: In the course of evolution the necessities of life develop into the happiness of life.

Those beings in whom pleasurable sensations attend the tasks necessary to life will carry on these tasks better and more completely than will others, who are brought to labor only by force of necessity. Hence, in the competition for existence, or in the course of adaptation, such beings are at an advantage, in comparison with the discontented, and have a better chance to transmit their characteristics. Thereby is established a progressive confirmation and intensification of this vitalizing tendency, which gradually becomes a fixed peculiarity of the species. The case is similar with regard to the taking of food. Eating and drinking came to be ranked among the chief ceremonials of men, as a result of uncertainties and irregularities in the food supply. In highly civilized environments the custom survived, along with the sentiments that prompted it, as a consequence of the law of biological inertia, for long generations after the conditions which created it had passed away. Thus, we still punctuate our festivities of various kinds with banquets, during which the festive spirit usually reaches a maximum. Again, the decisive function for the continued existence of a species, reproduction, is safeguarded by a strong development of the corresponding emotions. The mode of life and the character of most of the higher animals undergo marked changes at the time of mating, and we see such animals instinctively make the greatest sacrifices for the preservation of their young. If we ask how it is with man in this regard, we have only to consider the content of art. Ninety per cent. of all poetry relates to love, and the personal experiences of most individuals further go to show that the emotions aroused in connection therewith and the feelings of happiness and misery are keener than any other emotions that affect mankind. In this, some men have a different experience, or express themselves doubtfully. These are the *creative geniuses*. They often declare that in hours of greatest productivity they have a sense of profound or even of inexpressible happiness.

Labor, being a necessity imposed on life, has developed till it has become one of the joys of life. The completeness of this change of feeling varies with the stage of culture of the particular group. Desire for work has become instinctive, more especially among those peoples

who have longest been subjected to the urgent necessity to labor. It is, accordingly, largely a matter of climate; and we find that, in general, the instinct to work diminishes from high latitudes to the tropics. This aspect of work appears as a substantially modern conception. In order to appreciate the full significance of the point of view, it will be helpful to turn our attention for a while to an entirely different field; that of physical science. There, the idea of work (and of its correlate, energy) has begun to play a rôle so prominent as to be in fact the center and point of departure of our apprehension of life and of the universe.

In the narrowest physical sense, "work" is exclusively mechanical work, such as that required to move an object. Such work is performed when a locomotive pulls a train or when a man lifts a load. In these cases the work is made up of two factors, first, power or force; second, path or distance. The science of physics teaches us that the work is equal to the power (or force) multiplied by the path (or distance), because the product has the peculiarity that it is equally influenced by a change in either component. If either the force or the distance be doubled, the work will also be doubled. In virtue of measuring work in this precise manner, a very important law of nature is arrived at, called the law of the conservation of work, or energy. The essence of the law is, that by no means is it possible to obtain work out of nothing, but only to obtain one kind of work out of another kind of work, under the limitation that the total work obtained can never be greater than that used to start with.

According to a familiar anecdote, Archimedes declared that if he had a lever long enough and a place to rest it on, he could move the world. He figured that he could increase the force of his effort indefinitely by indefinitely increasing the length of the lever. Every laborer who uses a crow-bar has experimental knowledge of the effect, which, at first glance, seems incompatible with the conservation law. The apparent discrepancy vanishes when we remember that the short arm of the lever moves less than the actuating hand, so that just in proportion as we increase the force do we diminish the distance through which the force is applied; the work done at the short end of the lever remaining the same as that performed by the hand at the long end. Hence, while Archimedes might indeed move the world as he imagined, yet the distance through which it moved would be so infinitesimal as to transcend observation.

In a word, we may say that work is not creatable. We must be content with that which is in the world accessible to us. Still, our whole existence depends on work, in the broader sense. Whenever anything whatever happens, work is consumed, to be transformed into that which distinguishes the new from the old condition. The significance of

work, then, is this; it is the bottom principle of everything that happens. In a universe in which there were no work, nothing would happen. *Work alone conquers death.*

When Faust, saturated with the pseudo-science of scholasticism, cries out in despair:

> Geheimnissvol am lichten Tag
> Laesst sich Natur des Schleiers nicht berauben;
> Und was sie Dir nicht offenbaren mag,
> Das zwingst du ihr nicht ab mit Hebeln und mit Schrauben.
>
> (Nature, secretive in the bright day,
> Suffers no man to snatch her veil aside;
> And what she does not care to tell thee,
> Thou canst not force from her by rack nor screw.)

His utterance, in the light of natural knowledge, shows itself to be false. Nature tells man all he asks; only he must have learned to question her intelligently. How can he learn to do that? There is but one answer, through science. Not in ancient parchments, but in the fresh well of experience shall we find the knowledge that we need, which is fruitful and a sure guide.

We have seen that work can not be produced from nothing. But how does it stand with the reverse proposition? Can work be annihilated? The fact is, of course, familiar that in mechanisms of every sort there are seeming losses of work, or of "power" as we sometimes incorrectly call it. This is true, doubtless, but not the whole truth. It is all we knew of the truth till an original thinker, Robert Mayer by name, came upon the scene early in the forties of the last century, who was not satisfied with this meager information. The young physician, on the occasion of a journey by sea to the tropics, was assured by an old ship's officer that the sea-water is always warmer after a severe storm than it was before. This suggestion was enough to arouse in the mind of Mayer a series of questions. Might not the heat be produced by the large amount of work which had been done in raising the waves which had disappeared? The thought looked like an absurdity to the scientific men of the day, but, luckily, there were none of these for Mayer to question, as his ship lay off the coast of Java, and he followed out the line of thought, undisturbed by prejudices. In the steam-engine work is undoubtedly produced. Whence comes it? May not the work it does spring directly from the heat which it must receive in order to run? Work gives heat when it vanishes and, conversely, heat generates work in the engine. Are, then, heat and work things which can be transformed into one another, like two chemical compounds, or are they merely different forms of one and the same thing?

Filled with these reflections and with the conviction that he had attained a deep insight into the nature of things, Mayer returned home,

communicated his ideas to friends, and sought to convince them. The mathematicians among them were so affected by the faulty form in which Mayer put his theory, that they would not listen and paid him no attention, even after he had corrected the error. The professors proved no more amenable. One of them remarked, sarcastically, that if that were so, a bottle of water violently shaken ought to become warmer. Mayer, undeterred by the sarcasm, tried the experiment, the result of which is now so familiar to us as to seem almost axiomatic.

We see clearly that in doing mechanical work the *losses* of work, due to friction, result in heat. In a word, friction is a means of converting work into heat, just as a steam engine is a means of converting heat into work. Incomplete machines are those that transmute part of the work into heat, and the smaller this part is, the more perfect we call the machine.

Heat is, however, not the only thing into which work may be converted. It may reappear in the form of electricity, or of light, or of chemical change. All these things, out of which work may arise or into which it may be changed, we now call energy. While the law of the conservation of work has only a limited and ideal application, that of the conservation of energy is a natural law of universal application, without any limitation or exception. If we call those amounts of energy equal which arise from one another, we can, as the result of all experience, express the conservation law in the following terms:

Within a closed system, through whose walls no energy can pass in or go out, the total amount of energy remains the same, regardless of what happens inside the system.

In what light are we to consider this energy? Is it an actuality or a mere figment of thought? The reply can scarcely be doubtful. That which can not be created by any power in the universe, which maintains itself unaltered in amount in spite of all the unnumbered and protean changes to which it is subjected through all the ages, must be the most real thing we can conceive of. All efforts of the adherents of the older view to discredit the reality of energy have been fruitless, so that it is now thought of not merely as a formal thing, but as an essential entity, as a commodity which can be measured, stored, bought and sold. When you have the storage battery of your electric car charged up, and pay for it, what are you getting for your money? The battery is not heavier by the smallest fraction of an ounce. You have not purchased a figment of the mind, nor any mere abstraction, but an absolutely real thing, so many units of energy. You may think of it perhaps as electricity, but this is erroneous, since the charged battery contains its energy in chemical, not in electrical form.

Energy is more than *a* reality. It is *the* reality. No phenomenon, no effect, is anything but a (more or less transitory) manifestation of energy and, as such, is subject to the energy law.

Only ideal machines convert one form of energy exclusively into one other, desired, form. A plant is a machine that uses the rays of the sun directly for building up its body, a thing man can not do; but it is not a perfect machine, since it does not convert all the solar energy it receives to its own uses. From the human standpoint, a plant is a machine for storing up energy of solar radiation in the form of food for man. We have the data for comparing the energy available to the plant with that stored up. The result of the comparison is striking. The plant stores up, in fact, less than one-hundredth part of the energy it receives. The relation between the total energy received by a machine and that which it utilizes we call the figure of merit of the machine. This technical expression is but an extension of a colloquial figure of speech: thus, we call an electric generator "good" if it converts 97 per cent. of energy received into electric current, and "bad" if it only converts 85 per cent. *In the final summing up, the moral concept of "good" and "bad" must unavoidably rest on the same basis, inasmuch as all things that happen are but energy manifestations.*

Every change in the form of energy is accompanied by a dissipation of part of it in the form of heat. This loss may be compared with the material losses, in the way of saw-dust, chips, etc., which accompany the work of carpenter or stone cutter. We may look on the heat dissipated by machines as an undesirable by-product. Actual machines fall far short of ideal ones in their figure of merit, that is in their efficiency, but those made by human hands are relatively much less wasteful of energy than those furnished by nature.

The inefficiency of our practical mechanisms, compared with their theoretical efficiency, is a measure of our stupidity or unskillfulness. In this respect improvement is constantly taking place. All technology is devoted to the conversion of crude energy into forms useful to man. The "figure of merit" in the transformation is a gauge of our culture in this field. Let us consider what is the scope, upward, of technology in the sense referred to. We have not yet quite got rid of the ancient view of *work,* and hence of technical operations, as being something *low.* It is interesting to recall that Aristotle held the institution of slavery, on which the civilization of Greece and Rome rested, to be inevitably necessary for all time, since he could not picture to himself how the crude labor of grinding corn, pumping water and the like could be done at all, if not by slaves. Later times have taught us to solve the slave problem by the inanimate agencies of wind, water and coal, which make superfluous the lowest forms of human labor. In this illustration we see to what a high degree technical progress has had a humanizing influence by reducing the amount of de-humanizing work. Without technical advances, we would have to have slaves to-day, and would still be, in the development of social conscience, ages behind

what we are. All the ethics and morals ever thought of never could have effected this. We must eat before we can philosophize!

Of yore, figures of men and women in the sweat of their brows, digging, were a symbol of humanity. The symbol of modern mankind is the man who, by switch-board, steering wheel, or dictograph, expends enormous amounts of mental energy with but trifling muscular effort for the attainment of his ends. This elevation of man from the level of the ox to that of a higher being, who controls absolutely amounts of energy thousands of times greater than that represented by the muscles of his body; this is a great ethical gain which we owe exclusively to technology.

We may also find ethical applications of the idea of "figure of merit," or the efficiency relation. Jesus said of Himself that He came to bring peace into the world. Unfortunately, in the outcome, the sword was more prominent than the dove, and the church, as such, did but little for the realization of the idea. However, the perception that warfare involves an immense waste of energy, both in actual war and in armed peace, is a view destined to be of decisive effect.

To be delivered from waste of energy is to be delivered from evil. Take the most abstract of the sciences, philosophy, and the most abstract branch of it, logic. What can *that* have to do with transmutation of energy or with improvement of efficiency? Logic has for its subject the laws of thought, and for its object the avoidance of defective thinking. Let us suppose its object so far attained that only very few individuals are any longer guilty of drawing incorrect conclusions. Who can estimate how colossal is the waste of energy which would be spared if men almost invariably thought correctly, and were accordingly noble and virtuous in their dealings? In that happy state, all those energies now expended for judiciary, for punishment, for police and for government, would be set free to use for higher ends.

Ostwald emphasizes the ethical side of all these considerations and condenses the whole into a principle, called by him the energetic imperative, valid in all phases of our lives, technical, intellectual, ethical; as follows: "*Waste no energy, use it!*"

We know energy in two states or conditions. In one it is free to do work, or to be transmuted. In the other, it is in a dissipated state, like a cup of water poured in the sand, and is not available for use. It we call "bound energy." We are, then, expressing the facts of observation in saying, "any given amount of energy consists of two parts, free and bound."

Now, in every process of any kind, a portion of the free energy becomes bound, but never does any part of the bound energy become free. Everything of which we have knowledge as happening is subject to this law. Hence, the utmost limit of human achievement is, that we should

seize a part of this ceaseless river of free energy (mainly from the sun) flowing by us to the sea of dissipation, and divert it to human uses. We can never increase its amount, but by ignorance or maladroitness we may waste or destroy some of that part which is available to man, by facilitating instead of reducing its dissipation. Each of us is, then, made a trustee of that single working capital, that foundation of our collective possibility of living, and his value to mankind is measured by the proportion of total free energy that he takes from the general stream and applies to the benefit of the race. If, however, by carelessness or misuse he allows the free energy which is under his control to become dissipated, he is guilty of a crime against the general welfare which can never be made good; because dissipated energy can never again be converted into free energy. It is the sin against the energetic imperative and has the qualities of unforgivability and irrevocability that have been ascribed to the sin against the Holy Ghost.

The rule of natural law is much more "humane" than that of man-made law, although infraction of the former is indeed punishable, in so much as the life of each individual is rendered more arduous and unpleasant in proportion to his aberration from the natural laws of vital phenomena. But these laws are not something imposed from without. They form part of the very texture of his being. He only needs to see himself rightly, to be impressed, not only with the inevitableness of natural laws, but with their desirability. The law that a straight line is the shortest distance between two points does not trouble us, since we do not have to go that way unless we prefer it. But we have every ground for satisfaction that we know this law and have since early childhood learned its practical application, for this knowledge enables us to reach our destination by the shortest path and so puts us in a position to act in harmony with the energetic imperative and to visit our friends without undue waste of energy!

Ostwald states that he learned not to force himself to work when he did not feel inclined toward it, and so accomplished much more in the end, because there was no waste of energy in overcoming the resistance of disinclination; and argues that the aim of our practical social ideals should be, so to arrange *all* labor as to conduct it in like manner. This would conduce to the greatest happiness of the greatest number, and all would be working to the greatest advantage, since working voluntarily.

The energetic imperative requires, in fact, that we should remove out of our lives and those of our fellow men every compulsion, every opposition to individual preference so far as is compatible in any way with living together.

To the scientific man, natural laws are not commands, but guide-posts, whose purpose and use is to show him the way to a truer and

fuller life and to inner content; and he can not fail to desire to see the social order conform to this type so far as possible.

The ethics of the New Testament is generally and rightly thought to attain its climax in the injunction: "Love thy neighbor as thyself." One is nevertheless compelled to ask whether *love* can, in fact, be the subject of a command or an injunction. *Love,* is it not the freest and most personal thing there is? The natural philosopher must recognize the existence of an incompatibility here and change the content of this conception as science has changed the concept of law. A natural law is not a prescript, but a transcript, a simple statement of how things actually are. So, in the ethics of science, the doctrine of the conduct of man toward man must have, not the character of a juridical law, but of a natural one, one which shall inform us, which shall instruct us, as men among men, how we can live a peaceable, efficient and happy life. And if, perchance, on this path we meet love, it will come to us not as a thing prescribed, but as an incident and as the most natural, inevitable thing in the world. The road that leads from an insight to a sentiment is often long, but education helps, self-education in case of the more competent; for the rest, education of the children's school type. But by opening our eyes we can find love already present without either command or education. First of all, self-love, in every living being. Not by the most exacting ethics will self-love be objected to, so long as each individual is isolated from the others. But under these conditions there can be no ethics, in the widest sense. When the life lines of two beings cross one another, conflict begins. It is the conflict for existence, in which there is no ethical content whatever. On the contrary, it is the direct source of that which we call evil in the world. Simultaneously therewith good also begins to appear.

Deep is the riddle that comes with life, for with life comes the function of reproduction, so that through the activity of each individual a second enters the field, which is to the first a competitor and an enemy. To ensure perpetuation of the species, each being of the species must, through its offspring, contribute to the keenness of the competition which he himself must contend against. A strange situation!

Further, the functions involved in the perpetuation of the kind are bound up with a complex of instincts and feelings that exceed in power all others, even the love of life. In the simplest organism, consisting of a single cell, reproduction takes place by division of the cell. There are now two beings where there was one before, but it is impossible to say which is parent and which the offspring. If they were self-conscious, we may well imagine that they would learn only by experience that they had become two. Something of this sentiment of identity is to be seen in the feelings of the mother toward the young, in the higher

animals and in man. The most elementary form of love is that of the mother toward the child, and it is a direct development from self-love. The cat-mother who defends her kitten with her life, later shows toward it an increasingly unfriendly attitude. With decreasing dependence of the young life there is a diminution of parental love. Among gregarious animals that find an advantage in living in groups, the affectionate relation lasts much longer, but the change finally comes.

Here the sources of love lie open before us. Parental love is an elementary phenomenon, resulting in the passing of the instinct of self-preservation from the individual to the species. From the same source arises sexual love and also the bond between members of a family, which makes each ready for a measure of self-sacrifice for the protection of the others. From the family to the tribe, from the tribe to the race, from the race to mankind, the same process extends and develops, and this development is equipollent to and largely identical with the growth of ethics.

The energetic imperative enters again here. If we ask why a family or a group of animals or, specially, of men, hang together, the answer is that it is to their mutual advantage, because it brings in numerous ways an economy of energy in the securing of shelter, food and defense. As soon as the group is formed, the conduct of each member must adapt itself to the requirements of the group. Those whose behavior is most beneficial to the group are highly esteemed and their demeanor becomes a pattern for others. Those who have not modified their individualistic instincts to harmonize with the standards of the group are treated worse, or may even be punished or turned adrift. Often one member of pronounced individualistic instincts appears, who combines therewith great abilities and personal force. He may subordinate the others and compel them to serve his personal interests. The condition thus created, if it continues long enough, gives rise to an ethics in which obedience to the ruler appears as the greatest virtue, and opposition to his will as the most heinous offense. Out of this condition, according to our author, grows the type of morals presented by the higher religions and summed up in the injunction, love God above all and thy neighbor as thy self. This is the moral system of an oppressed folk, who give to Cæsar what is Cæsar's and who contrast their joyless lives on earth with the higher existence hoped for early in the future, for which they seek to prepare by the exercise of love toward those who are to be their fellows for all eternity. Ostwald lays stress upon the point that the foundation of this morality has been shaken by the fact that the kingdom of Heaven, expected so soon, has not as yet put in an appearance.

The demands of the present will, however, not be denied, and under their pressure a new, unacknowledged morality has arisen, containing the living elements of the old, adapted to the changed environment of to-day.

As for love, it is an instinct which has grown to be a moral necessity—a social compulsion that has been so fully absorbed into the individual consciousness as to assume the character of love. Rephrasing the old injunction, to meet modern needs, we find the new form of the ethical ideal to be:

> **Love thy neighbor in proportion to his social worth.**
> **Love thy people and mankind more than thyself.**

The crux and point of departure of Ostwald's ethical views, as may be perceived from the foregoing exposition, is to be found in the tacit assumption that the activities of mind are but variants of energy, in the sense in which this term is used in physics. It is, then, strictly comparable with the phenomena of electricity, of heat, of matter in motion, and must be intertransmutable with them, as they are with one another. If the assumption is valid; the principles of thermodynamics are applicable in the domain of Mind and Ostwald's philosophical edifice rests on a solid foundation. If it is not valid, his entire line of argument is reduced to a reasoning by analogy.

Let us then ask, whether the deductions from experience that we call "laws of thermodynamics" are such as to necessarily include *all* forms of energy or only those which we have learned to measure, as chemical, electrical, mechanical or thermal energy. The latter we can, and do, quantitatively determine. When a phenomenon involving them occurs, we can measure the exact number of units of each energy-form present both before and after the phenomenon and, by doing so, we know that the sum of these units previous to the phenomenon is equal to the sum of the units after, although the relative amounts of the different kinds may have greatly changed. This is the essence and substance of the positive knowledge from which the theory of thermodynamics has, by logical methods, been deduced.

If we use the term "energy" for powers that are not quantitatively determinable, that we can not measure in so and so many heat units, we should make it clear to ourselves that we are applying it to something that may, or may not, be identical with the "energy" known to physics. Its identity remains to be demonstrated.

At present, it is difficult to conceive by what experiments the "energy" represented by any logical process or by an emotion of love, hate or fear, could be measured in units of heat or electricity. It is, in fact, so difficult as to arouse a strong suspicion that intellectual and emotional manifestations of mind are something else than forms of physical energy. But, whether or no this suspicion corresponds to a "truth," it is certain that no one has yet affirmatively shown that such phenomena are subject to thermodynamical laws and, until this *is* shown, the reasoning of Ostwald, highly interesting and suggestive as it is, can not be held to be without logical flaw.

THE NORMAL CHILD: ITS PHYSICAL GROWTH AND MENTAL DEVELOPMENT

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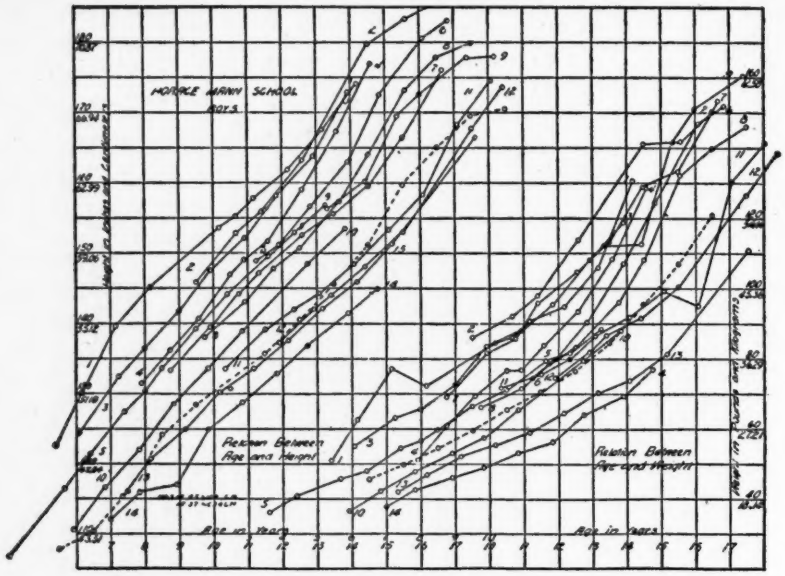
FOR purposes of psycho-educational analysis it should be recognized that a child has five parallel or interrelated ages: a *chronological age* in years, months and days, denotive of the temporal span of life; a *physiological age* denotive of stages of physical growth and maturity; a *mental age* denotive of the ripening of certain instincts, capacities and mental traits; a *pedagogical age* denotive of the rate and position in school progress; and a *moral age* denotive of fairly well-defined nodes of development in moral judgment and religious awakenings. In a normal child these ages balance each other.

This paper presents the results of a study of the physical growth (physiological age) and the pedagogical age (school standing) of a group of boys and girls from six to eighteen years of age when observed consecutively. The chief value of the study lies in the fact that it is the first attempt to follow for any considerable length of time the same group of individuals through the elementary and high schools, either in physical growth, school standing or the relation of the two.

The scope of the investigation includes, first, a series of norms based on the height, weight and age distributions: the average and average deviations of individual yearly and half-yearly increments of growth in height, weight and lung capacity; and individual curves in height, weight and lung capacity with health notes, and weight, height and vital indices. The second part of the paper deals with the school standing of the same individuals in marks, grades and ages; the third with the relation or correlation of physical growth to mental development as shown in school progress. The data comprise 43,840 measurements on approximately 1,000 boys and 1,000 girls, and 21,683 final quarterly term marks for 135 of these same boys and girls from the Horace Mann School at Teachers' College, New York, the University of Chicago Elementary and High Schools and the Francis W. Parker School in Chicago.

That these boys and girls form a select group and that school-medical inspection, directed play and physical training are important educational agencies are shown by the fact that on the average these children are taller, heavier and have better lung capacity than any other group in a series of 112 groups extending from Quetelet's first study in 1836 to 1914, and comprising over one million individuals.



HEIGHT AND WEIGHT CURVES. BOYS.

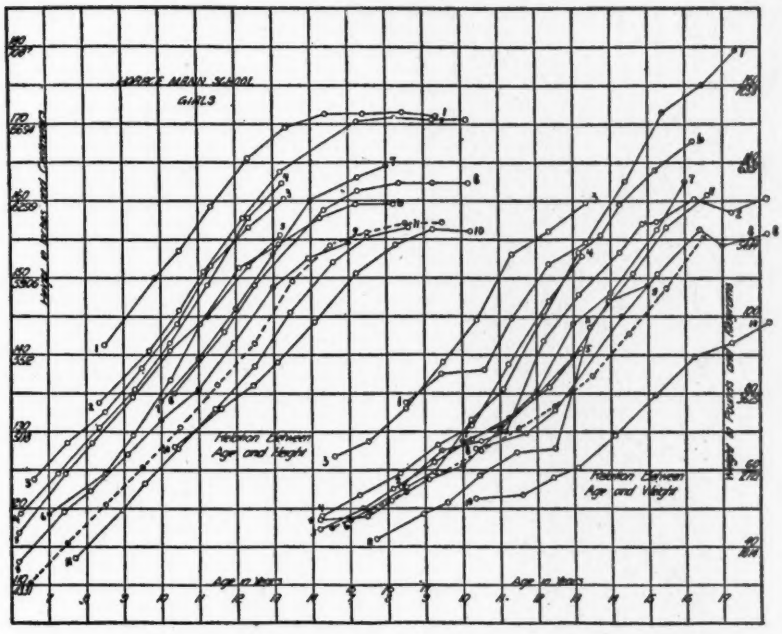
The base line divisions represent periods of one year; the vertical divisions represent 5 centimeters in height and 10 pounds in weight. The degree of pitch of the line shows the relative amounts of increase of absolute increments for the same individual. The broken line shows Boas's norm.

In reply to the question how tall or how heavy is the normal child within this group, and how much lung capacity has this child, the distribution tables give the following medians in inches, pounds and cubic centimeters, respectively.

	8 yrs.	10 yrs.	12 yrs.	14 yrs.	16 yrs.
Height: Boys	50.3	53.5	57.1	60.9	65.7
Girls	49.2	53.0	*57.4*	*61.8*	62.9
Weight: Boys	57.2	67.2	76.8	96.1	111.8
Girls	51.3	65.5	75.4	*102.6*	108.8
Lung capacity: Boys	85.6	110 6	134.0	162.5	212.6
Girls	81.8	100.9	128.9	150.2	176.2

For the boys and girls below the median or normal height, the period for accelerated growth in height, weight and lung capacity is later than for those above and the growth continues longer. This is true of the schools individually and collectively for yearly and half yearly increments, and for the per cent. of gain over the initial measurements. In conclusion the nodes of acceleration or cessation are different for tall children and heavy children than for short and light children.

In answer to the question, "What relation does the growth of any one age or period have to subsequent ones?" it can be said that the per cent. of gain from year to year shows that each child remains practically

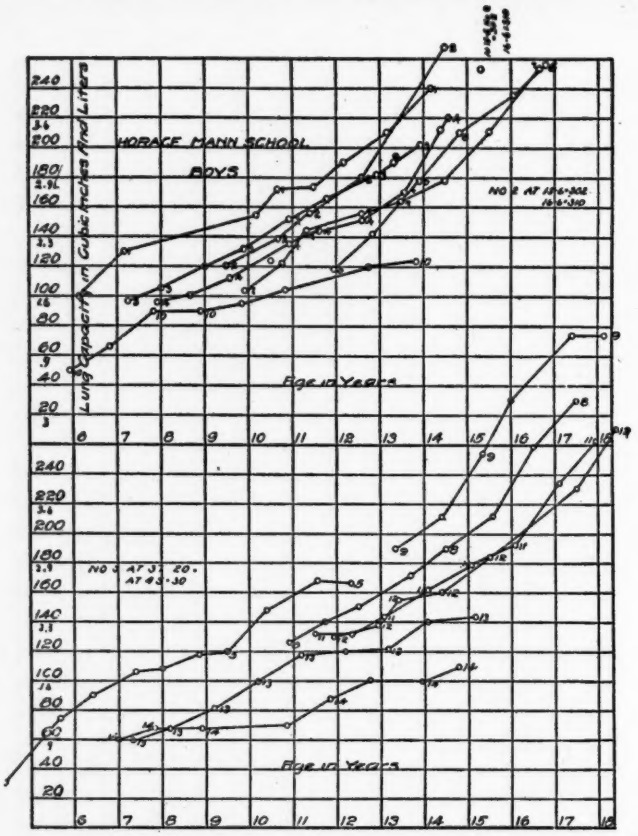


HEIGHT AND WEIGHT CURVES. GIRLS.

within its percentile group. Aside from the height and weight curves in 1890 for Dr. Weiner's four boys, no long series of curves have been available in scientific literature. Taking at random 170 individuals and plotting their curves for height, weight and lung capacity, we have 510 such curves for comparison.

In carrying out comparisons graphically among forms so dissimilar in absolute size as those of height, body weight and lung capacity, it was thought best to use the following units. In the height and weight curves the same base line division of 20 millimeters equals 12 months in age, while for the ordinates or vertical lines 40 millimeters equal 20 centimeters in height and 10 millimeters represent 20 pounds in weight. In the lung capacity charts a base line division of 15 millimeters is used for 12 months in age, and in the vertical or ordinates 10 millimeters represent 20 cubic inches in lung capacity. The original charts have been reduced in size and the millimeter lines taken out. The black lines represent distances of 20 millimeters on the height and weight charts and 15 and 10 millimeters on the lung capacity charts. The same Arabic numerals in a chart refer to the same individual.

Short children do not become tall, neither do tall children become short, under normal conditions. The per cent. of increase in height increments over the initial heights for a given chronological age from 6 to 18 is so comparatively uniform for each normal individual that the growth curves enable us to prophesy with considerable accuracy how tall a child of normal growth should be at any subsequent age within the



LUNG CAPACITY CURVES. BOYS.

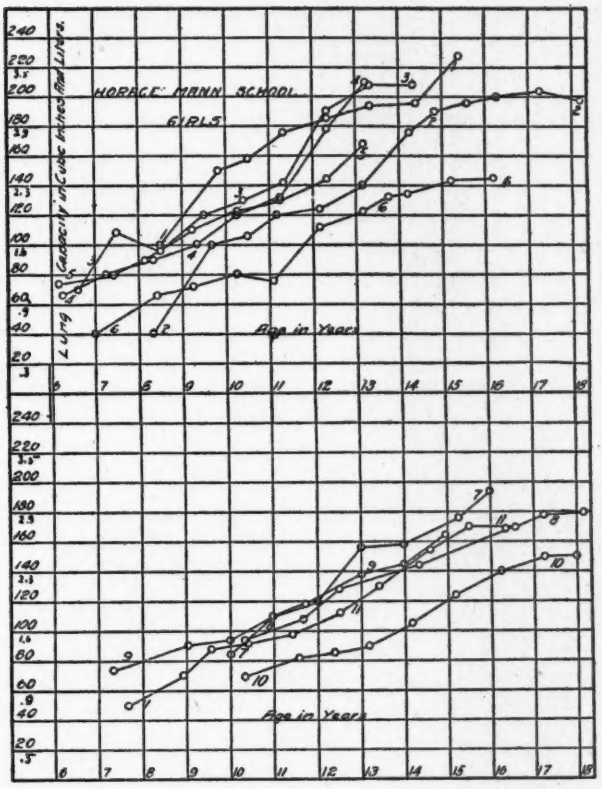
The base line divisions represent periods of one year; the vertical divisions represent 20 cubic inches in lung capacity. The degree of pitch of the line shows the relative amounts of increase of absolute increments for the same individual.

interim, provided his relation to any given median or norm be known.

The second significant point to notice is the relative shifting of the period of adolescent acceleration from 12½ for the tallest boy (No. 2) to 16 years for a short boy. For the tallest girl maximum height was attained at 14½ and for the shortest girl at 17 years, 3 months.

A period of marked retardation before adolescence is usually marked by a period of rapid acceleration during adolescence. If the increment of growth before adolescence is uniform, this uniformity tends to persist throughout adolescence. Where there is unusually rapid growth from 7 to the beginning of adolescence, there is frequently a decrease during adolescence. Marked arrests with these children usually occur during adolescence and persist throughout the period.

As a rule the weight and height are relatively proportionate to each other. Aside from irregular periodic fluctuations in height, each child retains relatively its position throughout childhood in regard to weight.



LUNG CAPACITY CURVES. GIRLS.

One of the most useful and practical indices of growth is the weight-height coefficient, which expresses the comparative solidity or robustness of the individual, and therefore, other things being equal, his general nutrition.

The lowest ratio in this group of boys is .15 at six years, and the highest .40 at 17½ years of age. There is little or no apparent difference, as a rule, between the tall boys and the short boys, except that the acceleration begins earlier for tall individuals. For example, if we take 0.23 as representing a given physiological stage of development, it will be noted that the time shifts chronologically in a fairly uniform manner between 7 and 8 years of age with No. 1, to 14½ years for No. 14.

It will be noted in the boys' lung capacity curves that No. 9 in the first chart, who is relatively heavier than the others for his height, also has more lung capacity. This is significant since the other boys hold approximately their relative places for height, weight and lung capacity.

The boys have greater lung capacity than the girls, on an average, for all periods except at about 13 and 13½ years of age. The develop-

ment in lung capacity for girls about comes to a standstill or decreases after 15 years of age; for boys the period is some time after 17 or 18. Marked arrests in height and weight are uniformly accompanied by arrest in growth of lung capacity. The boys and girls above and below median height differ in their periods of accelerated growth in lung capacity in a manner similar to the differences in height and weight.

In general it may be stated that there is more marked relationship between disease or physical defects and growth in weight than growth in height. Diseases seem to inhibit growth more during the late period of childhood than earlier. Accelerated growth and resistance to disease go hand in hand. The inception and removal of adenoid growth materially affect physical development.

Selecting the individual growth curves of the girls whose physiological changes have been recorded day by day during the periods of maturation, it is evident that the taller girls mature early.

Height and weight, therefore, offer excellent objective criteria for teachers and parents for determining the advent of menstruation as a factor in pubescent development and the onset of maturity. If the girl is tall, healthy and well nourished, this physical stage may be reached as early as 11 years in a normal girl; if tall, but underweight, it may be delayed; if very short and markedly light, it may be delayed until 16 years of age.

These conditions have wide educational application both in physical training and school work. They emphasize the fact that the smaller child should be treated as a younger individual, who has not the physical development and the accompanying mental disturbances and experiences which would seem to be indicated by her chronological age in years, and which, too often, has been used as a basis of classification, training and social activities.

It must be recognized, since we are investigating the school standing or pedagogical age, and since promotions are based on marks, school records must be taken at their face value, because they represent school practise and because they offer tangible criteria of the efficiency of the individual and of the school.

If we accept progress through school when measured by marks, age and grade distribution in highly specialized schools, as criteria of mental development or at least indicative of nodes of mental maturation, we have in this section of our discussion 135 individual pedagogical curves based on 21,682 final term marks in the common school subjects, music and deportment. The average school mark for the Horace Mann boys is 81.9 per cent., for the girls 85.9 per cent., for the Francis W. Parker boys it is 77.7 per cent., and for the girls, 80.9 per cent.

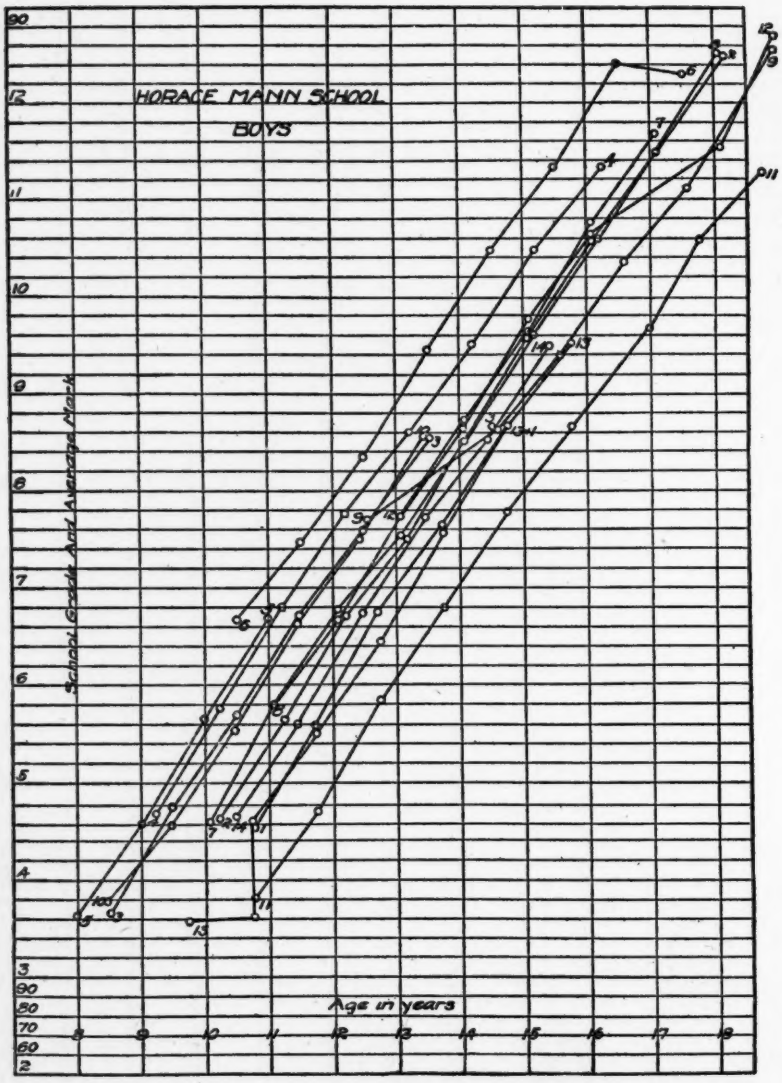
Some of the main facts are: Girls maintain a higher school standing than boys; there are also more repeaters among the boys; and fewer

cases of skipping a grade. In the fourth and fifth grades the boys and girls are approximately the same age, but in the last year in high school the boys are older on the average.

Expressing these tables in school standing in graphic form where 20 millimeters in the horizontal equals one year in age and 30 millimeters in the vertical equals one school grade, the two variables, age and school grade, may be expressed in the form of a continuous line. A third variable, or the average mark for each grade, may also be expressed, assuming the first 6 millimeters in the vertical within a grade to represent a standing between 50 and 60 per cent., the second 6 millimeters, between 60 and 70 per cent.; the third, between 70 and 80 per cent.; the fourth, between 80 and 90 per cent.; and the fifth, between 90 and 100 per cent. Thus it will be noted in the chart that the uppermost curve represents the most precocious child and the lowest curve the most retarded from standpoint of age and grade. No. 6 is the most precocious from the standpoint of age until he reaches 16½ years, and No. 11 the most retarded throughout his school life. On the contrary, comparing the average marks within the grade, No. 11 has higher marks than No. 6, as may be seen by noting the height of the circles in each grade.

Pupils who are relatively poor in the first few grades are relatively poor in the upper grades; that is, poor marks in the early school course are indicative of low standing throughout the school course. Boys and girls of normal school age or under maintain a better school standing, both as to grades and marks, than those over age for grade. The age of entrance after six or seven years determines the age for completing the elementary and high school. With very few exceptions these children progress through the elementary school at the rate of one grade per year, regardless of the chronological age at entrance.

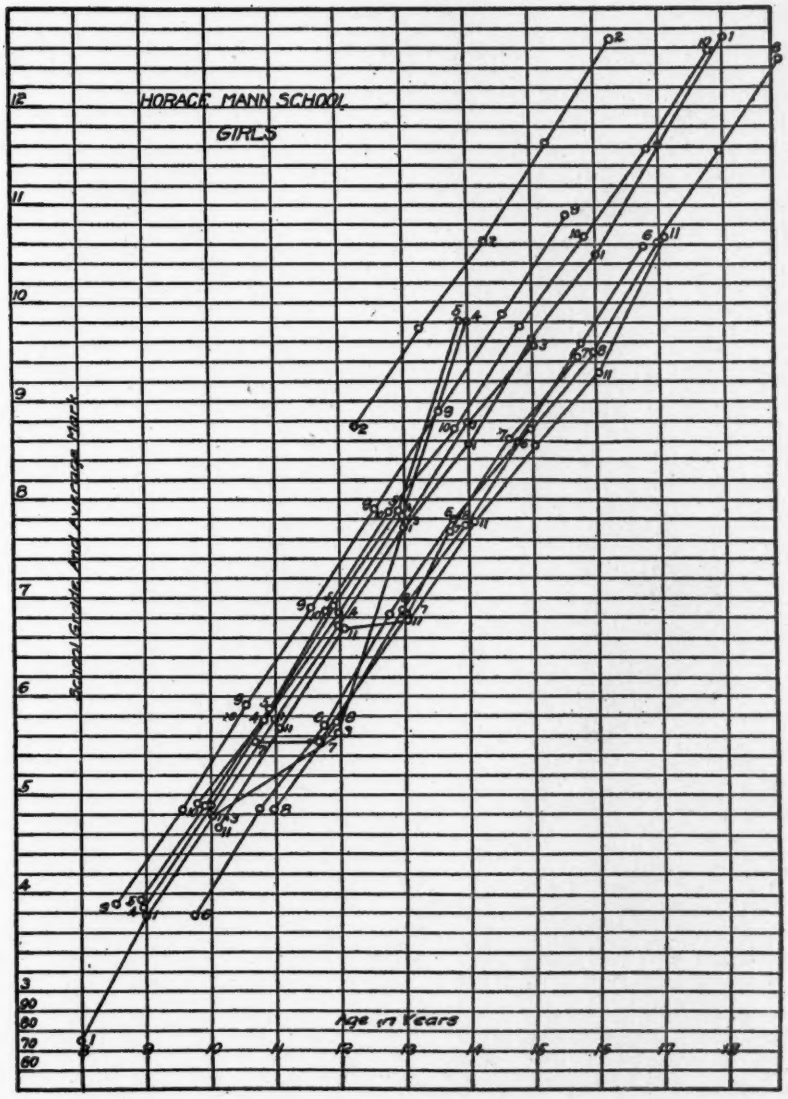
What is the relationship between these two? Accepting the pedagogical age as a fair equivalent of mental development, the first noteworthy fact of general significance is that among these children those of normal school age or younger maintain a better school standing both as to grade and mark than those age for grade. These are the physiologically accelerated or normal pupils. Those above median weight complete the last grade of the elementary school at 12 years, 9⅝ months of age with an average of 84.35, and those below average or of retarded physiological development complete the elementary school work at 13 years, 7¼₁₂ months of age with an average of 81.72 per cent. Checking the individuals whose curves have been plotted for age, height, weight, lung capacity, school grade and school mark, and giving the results graphically, it may be seen that the majority of children above median height are in or above normal grade and above the average in marks. Of those below median height the majority of children are below or in normal grade and below average mark.



SCHOOL STANDING CURVES. BOYS.

The base line divisions represent one year in age, while five of the vertical divisions equal one school grade. The average mark for each grade may be determined by assuming that the first division of the grade represents a standing between 50 and 60 per cent., 2d between 60 and 70 per cent., 3d between 70 and 80 per cent., 4th between 80 and 90 per cent. and 5th between 90 and 100 per cent. The degree of pitch of the line shows the relative amounts of increase of absolute increments for the same individual.

The main educational corollaries which logically follow from this study would require that our school systems, public and private, be graded on the *physiological age and the accompanying stage of mental maturity* of boys and girls in place of the chronological age, as is now



SCHOOL STANDING CURVES. GIRLS.

done. This would require that tall healthy children of accelerated physiological age be encouraged to proceed through school as rapidly as possible within the limits of thoroughness, and that the small light children of retarded physiological development be kept below or in the normal grade doing supplementary work, *since these short light pupils are immature in mental development, although in many instances precocious in brightness.* It also follows from the study that rapid healthy growth favors good mental development, and therefore the healthy growing child should have plenty of physical and mental exercise.

COMMON FACTORS IN MENTAL HEALTH AND ILLNESS

By Dr. F. LYMAN WELLS
McLEAN HOSPITAL

Denn sie hatte,—wie die meisten Menschen,—nur die Wahl zwischen Tobsucht und Ergebenheit.—*Simplicissimus*, 18, 661.

I AM asked to deal in these remarks with variations in different human traits which are produced by pathological conditions. For example, although in health John's eyesight is sometimes better or worse than at others, yet John's eyesight is so consistently better than James's that we speak of John as having better eyesight than James. But John's eyesight might become much worse as the result of a central lesion, and, if it remained fairly stationary at its new level, John would have much worse eyesight than James as the result of the pathological condition, and a new individual difference would be produced. The psychoses of which we shall speak, however, do not act in altogether this way. The differences associated with them are not sufficiently stable at any one level to make it just to say, *e. g.*, that a *general paralytic* has on the average one half the memory capacity of the normal. We can therefore speak of the kind, direction and limits of such changes, but not of their amount as representative of any clinical group.

It is one of the gentle ironies of scientific history that the concept of individual differences should have originated with one of its least significant functions. One must needs be the assistant of a pre-Galtonian astronomer to suffer for his simple reaction time. This fact, together with the necessary technical complications, has not encouraged the accumulation of pathological data on the "personal equation." The most important determinations are those of Diefendorf and Dodge, on the reaction time of the eye-movements. They found lengthened time in all the psychoses tested, slightest in the *manic-depressive excitements* and in *dementia præcox*, most marked, as would be expected, in *manic-depressive depression*. The angular velocity of eye-movements was found by these authors to be somewhat more rapid than normal in *dementia præcox, general paralysis*, and slightly also in *manic-depressive excitement*, while the slowest movements were seen in the *depressions* and in *epilepsy*. The generally quick movements of manic cases and the slowness of depressed ones are a clinical commonplace.

The rapidity with which some small movements can be repeated has a special neurological meaning, and many observations have been made with the psychoses. The rate is probably a little faster than the normal

in *manic* cases, but if anything more fatigable. It is much slower in the *depressed* phase of the psychosis, and increases somewhat as it is kept up, and the retardation is partially overcome by the continued work. E. K. Strong has recently followed this and other functions through different clinical stages of the disorder. Nothing particular has appeared in the other psychoses, save that in terminal cases of *dementia præcox* a disorganization of control is sometimes seen, similar to what appears, and would be expected, in coarse nervous lesions. W. G. Smith found a rate averaging a little above the normal in *epileptic* cases, owing to a notable persistence of speed.

The most psychologically interesting observation of choice reactions is that of Franz, in which the psychomotor retardation produces a longer simple than choice reaction time, owing, apparently, to a greater overcoming of retardation in the more complex process. A similar finding is reported by Marie and Vaschide.

The tremors of the "steadiness test" play no part in mental pathology outside of the coarse nervous lesions. Defectiveness in the speech movements, where it is a real defect and not a mannerism, is usually also produced in this way. For the same considerations as apply with the eye-movements, accurate registration should enhance their diagnostic significance. Something of the sort has already been reported by Scripture in reference to *epilepsy*.

A number of fairly definite motor phenomena of the psychoses ought to be mentioned, though they have not been brought under experimental control. Retention of the limbs in positions where placed is most common in *dementia præcox* states, but is also seen in extremely retarded cases of the *manic-depressive* type, where it has been psychologically interpreted as an extreme ideomotor perseveration. Closely allied to this is the type of motor disorder in *dementia præcox* known as "waxy," or *flexibilitas cerea,* in which the limbs are movable from one position to another like those of a wax figure. On the other hand, the resistiveness may be of the spring type, the member strongly resisting displacement, and at once returning to its original position. Extreme motor stupor combined with mental alertness is also met with in this psychosis; while the stereotypy and mannerisms of normal life are often tremendously exaggerated in it.

There is a good deal of ground for suspicion that these phenomena are far from motor in the sense that they originate at the same levels with tremors or reflexes. Thus in some cases the resistance to pressure is begun in anticipation of the pressure, and, if, for example, a finger nearly but not quite touching the forehead be slowly drawn away, the patient, resisting the suggested pressure, may bend forward until equilibrium is lost. There is more likely an ideational element in such phenomena, and like their counterparts that we shall see among the

higher mental processes, they are obscurely purposeful. So also are the impulsive acts of *dementia præcox* as compared with those of *general paralysis.*

The psychology of feeling is one in which the standpoint of individual differences has played very little part. The field is both tempting and difficult, and there has been the least progress in proportion to the experimental work done in mood and emotional reaction. Common observation shows that there are true individual differences, and for the adaptation to life, these differences are of paramount significance.

In many of the psychoses, the mood and emotional reactions are markedly and fundamentally altered. Heightened emotional sensitiveness, or lability of mood, is especially characteristic of *exophthalmic goiter* or *Graves' disease.* The source of intoxication here being internal secretion, it is a noteworthy illustration of the interdependence between mental activity and various extraneural processes. Functional atrophy of the thyroid gland is accompanied by a converse picture showing dulness and stupor, and with generally opposite symptoms, both physical and mental, to *Graves' disease.*

Still other psychoses are characterized by feelings of exaggerated well-being. The *manic excitement* shows a typically active exhilaration, often with no apparent diminution of intellect, manifesting itself as we should expect to see it manifested in an exaggeratedly happy normal person, with dancing, singing, jibing, half-jocular overestimations of one's powers and the like. Another phase of the *manic-depressive psychosis* shows a sort of mute transport, or silent ecstasy, in which it is very difficult to get at the mental content at all; it is termed the *manic stupor.* The most genuinely beatific state of mind that is maintained in terrestrial relations is probably seen in *general paralysis;* a state of easy-going, beaming euphoria, which the patient himself has no words to describe, but which finds some expression in grandiose but feeble delusions, scarcely if at all reacted to, as that he possesses countless millions, is king of the world, the super-god. It is interesting to note that this unitary disease process is associated with a great variety of mental pictures, sometimes with melancholic symptoms instead of the euphoria.

Simple, persistent depression of spirits is not a normal mental reaction to any external cause, but it is a most common reaction of the psychoses, where it is classified with the *depressed* phase of the *manic-depressive* group. This is the correlate of the *manic* condition above mentioned, sometimes alternating with it; though alone, it represents much the more benign process of the two. As in exhilaration, a number of delusions may arise secondarily to the emotional condition, which here favors depressive or persecutory interpretations of the events about one. These ideas are generally superficial and changeable; there is

quite another origin for more fixed and elaborated delusions, as we shall see.

As in normal life we notice that some people are quiet when they are depressed, and others agitated, so here we have very agitated as well as retarded or even stuporous melancholias; the latter especially in younger people. All forms tend towards suicide, and as the condition is not necessarily accompanied by any of the features popularly associated with mental derangement, it happens that many, perhaps the great majority of suicides are allowed to occur in this way.

The underlying mood regularly influences the emotional reaction to the environment. So while we contemplate with gladness the signs of returning spring, the melancholia is more depressed by them. It is also a law of normal emotion that a mental process with strong emotional reaction tends to endow with similar emotional value any mental process with which it stands in close association. Thus if we witness a very harrowing accident on a certain street, it is not pleasant for us to pass down that street next time—we may even pass down another street, though it is no safer to do so—and what is most important, the unpleasantness of passing down this street can exist whether the memory of the accident comes into consciousness or not. Such transfers of emotional reaction are worse than useless in life, and the personality much subject to them soon ceases to be "normal." In psychopathology it has long been observed that incoordinate emotional reaction—the "intrapsychic ataxia" of Stransky—particularly characterizes the mental pictures of certain neuroses and of *dementia præcox*. The psychogenic origin of these "ataxias" in normal life is clear enough, and in these disorders it can be traced sufficiently well to make it improbable that any new process is involved. The connection is often bizarre, especially in *dementia præcox*.

Although it is far from the most difficult of psychopathological questions, but little knowledge exists on the subject of the speed of the higher mental processes beyond that afforded by clinical observation. Many of its basic problems are scarcely touched. Thus we do not know whether mental time in *manic excitement* is quicker than normal, and if it is, at what level of the nervous system the difference lies. The elementary process of addition has been found to be somewhat more rapid, at least at first, in *manic* than in normal individuals, but how far this is gained at a sacrifice of accuracy, or whether staying power would be as good as normal, does not appear. There is no question however, of a specific slowing in the case of the corresponding *depressed phase* of the psychosis. We have spoken of it before at the motor level, and it can pervade the entire mental system. Clinically it is here known as "thinking difficulty," and is shown by general delay or loss in responses that require mental effort. It may simulate a memory

defect. The normal range of about 2:1 in such processes is thus indefinitely extended.

In other mental diseases these questions scarcely apply. Thus we do not speak of a characteristic psychomotor retardation or acceleration in *general paralysis, arteriosclerosis,* or *dementia præcox.* Only in the case of immediate drug intoxication has a stimulating effect been attributed to such poisons as alcohol, morphine and cocaine. Experimentally, the effect of alcohol seems to be to remove inhibitions, so that there is greater freedom of motor response. Many premature and false reactions occur. Morphine and cocaine are too dangerous for experiment, though both may be taken with the idea of temporarily stimulating the mental powers. The former does appear to bring about a certain facilitation of the thought processes, its effects being in some ways opposite to those of alcohol.

The range of normal variation is so great that few abnormalities in the association experiment can be attributed to pathological conditions except with knowledge of the subject's normal reaction. The rather stable character of the association type through normal life makes its fluctuations through the psychoses of considerable significance; but the individual differences there are of very doubtful interpretation. It is scarcely evident that there are features of themselves characteristic for different psychoses except in *dementia præcox,* where irrelevancies, neologisms and stereotypies are frequent in the presence of good appreciation of the experiment. "Narrowing of mental horizon," according to Kent and Rosanoff, is prominent in grave neural disorders such as *epilepsy* or *general paralysis.* Nothing approaching specific alterations has been observed in other psychoses. It is certain that normal performance is not incompatible with severe *manic-depressive* states; and the marked tendency to unusual associations—the prime feature of the psychoses in general—occurs also in personalities that are distinctly better than the normal average.

There is no clinical entity among the psychoses in which memory is improved, though the hysterical *hyperamnesias* furnish particular instances of it, as the corresponding *amnesias* do of memory gaps. Memory defect is a special characteristic of mental disease accompanying the coarser brain lesions, as *general paralysis, arteriosclerosis,* or *senile dementia.* It is most prominent in the last named, and also more especially associated with recent experiences. The loss in *general paralysis* is rather generalized over the entire memory field, and in *arteriosclerosis* it tends to be "patchy," so to speak, losing and retaining here and there, though not with systematic amnesia in the hysterical sense. The most prodigious memory defects are seen in a psychosis of usually alcoholic origin, the *Korsakoff syndrome,* where, in spite of good understanding, all impressions are immediately lost; indefinite

practise does not suffice to learn what a normal person gets with one or two repetitions. Memory seems essentially unaffected in *dementia præcox* and in the *manic-depressive psychoses,* though it may be masked by confusion, apathy or stupor. These factors are mainly responsible for the poorer performance in memory tests that most other pathological cases show.

Various attempts have been made to experiment with the suggestibility of mental life, as by measuring the extent to which judgments could be influenced by suggestion. Scott's ingenious experiments showed that this could be different in different functions, so that we might not speak of general suggestibility any more than we should speak of general sensory acuity. But as an acute sense of sight would be much more important for our behavior than an acute sense of smell, a relatively great importance doubtless attaches to suggestibility in the higher levels of conduct, though the level of human activity where suggestibility really counts be not represented in experiments on the simpler sensory and motor processes. In a sense, the distractible *manic* case might be called over-suggestible because he catches up the examiner's interjected phrases and weaves them into his talk, or is easily diverted from one thing to another. But it is in the *hysterical* and in some *dementia præcox mechanisms* that suggestibility is increased to the point of giving real control over conduct. The Lata of the East Indies, and the Jumpers of the lumber camps are the most conspicuous examples of the former. Here we see an automatic, positive response to the idea suggested. In *dementia præcox* this occurs, but is not so very common. The striking feature of heightened suggestibility in *dementia præcox* is that it is negative to the suggestion. Not only may the individual be "blocked," as we say, making no response whatever, but so far as possible the opposite response may be made. It represents the extreme of the "contrariness" that is met with in normal life. It even may become possible to direct the individual's actions through asking the opposite of what one wishes; but the negativism is strictly to the idea conveyed. These cases know what they are about, and when it is clear that the thing wished is the opposite of the thing suggested, it is no longer obtained in this way. Bleuler has given a unified formulation of how this symptom is related to the underlying psychosis to which latter I shall subsequently allude.

Individual differences occur in a number of mental processes more involved than the above, which are but slightly subject to experiment. There is no reason to suppose any specific alteration of sense imagery as a result of mental disease. But those hyperfunctionings of it that we call hallucinations are quite different in various mental disorders. There is a delirious type of hallucination produced by poisons, like alcohol, morphine and cocaine, generally visual, and not especially sys-

tematized. It has rather the appearance of a selective action of the drug upon particular nervous elements. The hallucinations of *delirium tremens* are typical of this. Epilepsy is said to favor hallucinations of blood, fire, and catastrophe; cocaine, images of a microscopic character. Detailed analyses are apt to be unsatisfactory, owing to the unclear condition of the patient; when the alcoholic reads from or describes in detail the picture on a blank page, he confabulates rather than hallucinates. A number of curious clinical observations, such as illusory completion of lost fields in hemianopsia, doubled hallucinations to prisms or pressure, made greater or smaller by opera-glasses, hallucinations in one eye or ear only, need be no more than mentioned.

Hallucinations are reported in all the major psychoses, but for the understanding of the clinical picture, they, and the delusional ideas which supplement them, play the most important rôle in those types of mental disorder which have been termed *biogenetic;* that is, where the personality *as such* fails to meet the normal mental demands of the environment, and reacts to it along certain fairly definite pathological lines. These types of reaction may be for us summed up in the *manic-depressive* and *dementia præcox* groups. A most significant development in the conception of these conditions is that their basic hallucinations and the delusions, whether or not involved with them, are the expressions, not of the selective action of some fortuitous intoxication, but of *instinct trends,* detached from, or not controlled by, the main personality, and lived out through fantasy. Both Tuttle from the pathological and Cattell from the normal side have indicated how ideas can develop into hallucinations through abnormal reaction to them. These hallucinations and delusions are thus absolutely continuous with normal imagery and imagination, and the minor satisfactions which these latter supply to the normal individual are here magnified to take the place of reality, in response to coercive instincts and desires for whose adjustment reality must be escaped. Are some patients beset by unrecognized erotic longings? The voices horrify them with accusations of immorality. Is there some obscure maladaptation in the patient's marriage? The response may be a tragic imagination of the partner's death. The husband who visits his wife is then not her husband, but an impostor. Or there may be a fancied alteration of personality, as when under similar circumstances a young man calls himself at different times "Harry Thaw," "Clarence Richeson," the "king of the fairies."

Following Cattell's formulation of those higher mental qualities not directly measurable, we should say that defects, particularly of *judgment,* lead to the most serious consequences in *general paralysis, arteriosclerosis,* and sometimes in *manic excitement. Refinement* deteriorates especially in *dementia præcox* and in *general paralysis,* being, however,

curiously preserved in cerebral syphilis; also comparatively well in the depressions. The preservation of *clearness* as opposed to clouding of consciousness is especially noteworthy in *dementia præcox,* confusion is most prominent in infective, exhaustive and toxic conditions. Many cases of *dementia præcox* have all the *originality* of Alice's White Knight; and the *catatonic* with his floor-polisher surpasses in *perseverance.* The most striking abnomalies with *Aussage* experiments would probably be met in the *Korsakoff* psychosis.

It is obvious that, in any social sense, *leadership* and independent *efficiency* are practically wiped out in the mental diseases we have discussed. The fact that as a group they must be removed from society sufficiently attests this, though in many cases a diminished capacity for work under direction is preserved. But to this rule there are important exceptions, which fall into three classes. In spite of real suffering from neurosis or psychosis, special aptitudes enable some persons to maintain themselves independently, and even to perform valuable service in a highly organized society. Most neurologists number such individuals among their patients. In a second group of cases there is a clearer connection between the greater efficiency and the immediate symptoms of the psychosis. There are two types of these. Mild cases of *manic excitement* derive therefrom an energy which, if only the judgment be enough preserved, enables them to do tremendous amounts of work, bear troubles, and carry off situations that would be impossible to them in their normal states. I have often quoted a case of alternating excitements and depressions who used his excitements to earn enough money to tide over his depressions in private hospitals. This *hypomanic* state may be constitutional, giving energy and capacity far surpassing that of normal men, but complicated with pathological features. The personality of Alexander the Great, with its stupendous accomplishment, its egotism and its excesses, is a distinct historical example. The other of these types of effectiveness results through *paranoic* rather than *manic* traits. *Paranoia* carries with it a faith, singleness of purpose, persistence and self-confidence greatly in advance of normal personality, but these regularly attach to ideas whose working out throws that individual permanently out of adjustment with the social order. But if the ideas are such as to arouse social response, great leaders are produced. In the religious sphere it is evident that strong personalities may found systems of belief which, not to mention the occasional amassing of worldly goods, attract many followers, and are genuine moral forces, with no other support than their autistic convictions and indomitable zeal. The inspiring power of such characters in secular history is fitly represented by Joan of Arc.

Lastly, we may take up the question of the general cohesion in the different elements of the personality. As one may gather from the late

Professor Pierce's thoughtful contribution to the Garman Commemorative Volume, the extreme cases of splitting that attract so much forensic attention under the names of double or alternating personality, are psychologically continuous with divisions of personality that are quite usual and normal. We sometimes think of *systematic amnesia* as the criterion of a real alternation of personality. The lives of many normal persons, however, are so ordered that they at various times make a total change of environment to another to which they are equally accustomed, but with practically no associative links between them. In such cases the abandoned mode of life may be lost sight of with truly hysterical completeness, and its most common passages require distinct effort for recall. The differences between these normal alternations of personality and those of hysteria are simply that the latter are more independent of environmental change, less subject to voluntary control, and in that the associations from the other personality or association system are more difficult of recall, they are more complete alternations. The pathological condition simply brings about the fuller working out of a tendency that in some degree is common to all of us, though never quantitatively measured.

The same is true of those splittings of personality where we do not have two or more associative systems alternating, but running side by side, and contending for expression in action; as in some reported hysterical automatisms, where the patient is said to write answers to one set of questions, and answer another by mouth. It has been remarked that all of us are a little hysterical, and it is again true that all of us are a little *schizophrenic*. Every one carries about with him numerous systems of likes and dislikes, attractions and counter-attractions, impulses and counter-impulses. Some of these favor the social adaptations of the personality, and others are in truly Mephistophelian opposition to it. The discipline of the former and the control of the latter are the balance of the personality. The lack of these qualities, with the conspicuous preservation of other mental functions, gives us some of the most striking features of *dementia præcox*. Here we observe that certain egocentric, sometimes formulated as autoerotic, tendencies, that all persons have in some degree, acquired a markedly independent organization, and crush the objective, social instincts of normal personality; covering it with hallucinatory insult, picturing to the mind's eye offensive scenes, preventing the personality from doing as it would, forcing it to think and do things which are hateful. The acutest mental suffering that occurs seems to ensue when the main personality attempts the unequal contest against them; sentiment can paint a lurid picture of its tortures in the death-grip of the destroying "complex." But as a rule these trends gain the mastery without the struggle; and we see simply the general failure of reaction to external things that gives us the apparent apathy of these cases.

It is quite probable, too, that there is a mere disintegration of the personality without its destruction by an organized trend; such a one is certainly impossible to demonstrate in many cases.

Here, too, it is easier to observe than to measure, and there is no telling now if the degree of personal integration for very complicated reactions will ever be brought under experimental control; for the lower psychomotor levels of reaction, however, there is considerably better hope.

I will quote two instances of the way in which this disintegration of personality is spoken of by the cases themselves. It is not often clearly expressed, *dementia præcox* cases being commonly inaccessible. First in the case of a young woman of twenty-five, with nothing very definite appearing in the previous history. At various times in the psychosis she makes such utterances as these:

> My mind seems to be in layers like strata in geology. . . . Something seems to push my mind into channels I don't want it to be in. . . . I don't know why I think of these things. I seem to be bound to find out a lot of things I am not interested in, as if some one was teasing me. It makes me feel frightened, as if I was changing to something else. It is like the difference between a good and a bad person. All at once I seem to wish somebody would die. I don't mean it, of course, but I can't keep it down. . . . If I could gather up a good will it would be all right. Instead these vague ideas seem to be wandering all around as if you were going through a sort of labyrinth. . . . I can't say anything I want to. It is like going through a river where there are a lot of weeds and they get in your way and you can't get through. . . . I seem to be imagining a lot of things. I can't get my mind together. . . . I seem all of a sudden to sink right down into deep thoughts as though I were covered up in a snow-bank. Whether it is a loss of the train of thought or of the spirit I don't know—it seemed as if my mind had been crushed back and I had lost control. . . . I try to use my mind but there is no thought there; it is empty. Somebody takes my mind away every two seconds. . . . If they want something to experiment on let them take a rabbit. I want my intellect.

And a young man of about thirty, of *shut-in personality,* and of somewhat coarser mental fiber than the previous case, expresses himself in this way, with more delusional coloring, the disconnected fragments of his own personality being rationalized as "spirits."

> My life is apparently in the hands of others the way I am now situated. . . . It seems as though the air about me were made thicker; it is condensed about me so that it gives the spirits some support, foundation, to act and carry on. . . . It is a peculiar trick for strangers to use other strangers in that light. . . . I feel as if I was supporting this column of spirit realm, as you might say, and I was wondering whether if hundreds of other spirits came into it if I could stand the tension. . . . The more persons that enter, the greater the tension, and in the last analysis I don't like any such existence. I am a human being the same as any one else, and I want my freedom and independence. . . . The spirits show themselves through voices, forms and various practises; they are very clever about some of their practises and cover them up. Any spirit that enters this realm can gauge the clearness and distinctness of the form—they can make them-

selves plain or just give you a faint idea of what they are doing, but you or any one else can imagine that they would be practises of sexual intercourse; of the spirits having intercourse with each other. It seems to me right now that this room is all filled with miles and miles of them all doing anything they can think of. . . . Now I am sort of carrying the load, as you might say, and any one who uses this (spirit) realm ought to be fair enough to keep out of my sight; I don't want to see all this business. Another thing, these people are total strangers to me, and if this business is going to keep me from engaging in remunerative employment there is going to be some remuneration, because I'm not running a free lunch counter!

We have reviewed the major exaggerations and distortions of personal traits which characterize the psychoses—individual differences due to pathological conditions. But there has been mentioned a group of disorders, the *biogenetic,* that arise upon constitutional incapacity for mental adaptation to life, and in this aspect do the psychoses represent pathological conditions due to individual differences. Here we see individuals, who, though in early years presenting no such abnormalities as would bring them into the group of *feeble-minded,* and adapting themselves at least passably well to the situations of childhood, yet, when they meet situations of a certain character in later life, are not able to cope with them as normal individuals, but are precipitated into psychosis.

The fact that these situations are common ones in every-day experience has been held to refute the supposition that they could be the precipitating factor in psychosis. Thus, if a girl, such as I have in mind, develops a brief, *dementia-præcox*-like episode on the death of an old lover, this would not be an occasion for the psychosis, because thousands of people live through the situation with no abnormal reaction. But this fairly obvious reasoning that the shock could not occasion the psychosis has to yield before the very obvious fact that it does. The truth is rather that in these individuals certain particular shocks would tend to be followed by psychotic reactions, and this girl developed her psychosis because, as further observation indicated, the death of that old lover *meant* to her something very different from what the corresponding event means to the average person.

Just what mental events will in any given individual be of the character to precipitate a psychosis is a psychogenetic matter, and varies as people's life-histories do. But that they have the property of precipitating one at all, and what kind of psychosis they will precipitate, depends on individual differences of constitution.

The most definite conception has been reached in regard to those mental constitutions on which *dementia præcox* reactions develop. It has been found by Adolf Meyer, August Hoch, and others who have repeated their observations, that individuals who develop these psychoses tend to be distinguished by a combination of traits which they sum

up as the *shut-in personality.* In the time at my disposal the conception can not be fully discussed. The characteristic picture, however, is one of repression, seclusiveness, secretiveness, failure of normal "participation in cares, pleasures and pursuits" of others, self-centered stubbornness as contrasted with aggressive persistence, special oddities of conduct, the so-called "in-growing conscience," strong religious or mystical trends, with relative emphasis of passive virtues. A concrete example is described in the following words:

> As a child he was precocious but in school had to study hard. He lacked confidence, was pessimistic, brooding and egotistical in disposition. He preferred reading to athletic sports, and gave religious scruples as a reason for not attending the theater. He did not use alcohol, tobacco, tea or coffee, and it was also noted that he did not care to associate with the opposite sex. At the age of 17 he began work as a clerk and was steady, honest and exact. . . .

The *manic-depressive* group shows a larger number of cases where abnormal traits are not seen before the psychosis, and the *shut-in* traits are nearly absent. But as an elementary point here it is brought out in some recent figures of Hoch's that persons who develop *manic-depressive* psychoses have also shown special tendency to exaggerated emotional reactions in their normal lives. These may be of either a euphoric or a depressive nature; when they are euphoric the individuals are more likely to have *manic* attacks, when they are depressive to have *depressive* attacks; and the melancholic personalities, manic ones. The apparent influence of the personality on the form of the attack diminishes to zero as the difference between the cheerfulness and depression of spirits in health becomes less marked.

In *dementia præcox* the psychotic mode of adjustment is regularly adhered to; in other words, the psychosis is not recoverable. The *manic-depressive* states, whose picture is as a whole much less detached from reality, represent rather a temporary mode of adjustment; that is, the psychosis is recoverable. The *manic-depressive psychosis* makes for any port in a storm; *dementia præcox* scuttles the ship.

Both conditions, however, with *paranoia,* and in a more circumscribed way the neuroses, show definite and *systematic* effort of adaptation to the patient's life-circumstances. The final understanding of these cases is given in the questions, *"Why did you have to have this thing?"* what made this adjustment a necessary one for the patient? and what needs must now be met in a more normal way, what particular danger points must be guarded, what false views of life corrected?

It is now apparent, I hope, that the mental criterion of psychosis is essentially one of mental maladjustment to the surroundings, and often it is the only criterion, mental or physical. The individual differences that distinguish psychotic and normal personalities are not so much differences in motor power, sensory acuity, affectivity or intellect, but

depend on the way in which this complex enables the individual to make appropriate reactions to his environment. An individual becomes psychotic when he fails to behave with a certain more or less arbitrary degree of appropriateness. Where the mental malfunctioning follows a sufficiently definite line, we may formulate a definite psychotic entity, as the manic-depressive or the hysterical states. The experimental side of the dynamic psychopathology is therefore distinct from the academic psychology in that it is essentially grounded in the measurement of the reaction's *adequacy* or *fitness*. It involves a fundamental recasting of psychological methods, more along the lines of comparative psychology, whose details have only begun to be worked out.

These things shall enable us to observe certain mechanisms of adaptation, from which we must learn about the individual's fundamental adaptability. There are very few adaptations which *every* individual must make, but life places very many persons in situations which *they* can not meet. Some can not meet them within themselves; they react with the "flight into the psychosis." Some can not meet them as members of society; they react along criminal lines. Others can do neither, and they have led us into the absurdness of a dividing line of responsibility for action where not the shadow of a line exists. We have seen how continuous all normal human traits are with the pathological. The value of all attempts at controlling the actions of men, as with automobiles or waterfalls, depends upon taking account of the mechanical principles upon which they act. A chief legislator of my native state lately remarked, "Men do not make laws, they discover them." The problems of the jurist, even more than those of the psychiatrist, are failures of mental adaptation; and as we discover its laws we shall discover the best laws to regulate human conduct for both the happiness of the individual and the order of society.

GERMAN MILITARISM AND ITS INFLUENCE UPON THE INDUSTRIES

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MILITARISM in its true sense is the defense of home and family which has been forced upon the continental nations for the reason that they live in such propinquity to one another. Germany, for instance, is surrounded on all sides by potential enemies. Its frontiers are contiguous to Austria, Russia, France, Swtizerland, Belgium, Holland, Denmark, and it is separated by narrow bodies of water from Sweden, Norway and England. What such surroundings mean is evident in our own case. We have only two neighbors, Canada and Mexico, and with each of them we have had wars and frequent disputes, such as the Alaskan boundary question, the sealing and fishing controversies, etc. Inasmuch as our comparative isolation has not saved us from trouble, it is most remarkable that Germany, bordering on ten countries, has had so few wars.

German militarism is the application of arts and science as well as the most perfect organization and administration to the defense of the hearth. The prominent features of German militarism are conscription and the standing army.

Conscription has made the defense of house and family everybody's business and not the affair of a few hired men. It has caused the uprising of this wonderfully united nation as one man during this war, and it is the reason for the boundless self-sacrifice of the people—men, women and children—who all feel that everything must be given up for the fatherland and that individual wants and necessities, worries and pain do not count until victory and peace have been achieved.

The standing army has been pronounced by an American author to be the greatest democratic university of the world. Conscription and compulsory military service combine to make it the army of the German people, and not that of the Emperor, and therefore, German militarism is not the militarism of the Kaiser but of the German nation. Every one from the highest to the lowest is proud to be a member of the army and to be able to contribute to the defense of home and family. Here men of all types of education, the university man and the artist, mix with the laborer and the farmer. During the period of service they learn order and discipline. They are taught the value of punctuality, of exactness, of cleanliness and of obedience. They become aware of

the fact that the individual is only a cog in the wheel of the big machinery. The few illiterate recruits from the most easterly parts of the country receive instruction in reading and writing; those recruits who have neglected to develop their bodies owing to lack of exercise improve in physique during their time of service, and in this respect the time spent in the army is of as much benefit as membership in an athletic club. The lessons learned are not forgotten by the soldier after his return to civil life, and order, discipline and the necessity of physical exercise become indelibly impressed on his mind.

It thus follows that the workingman who has had the advantage of a training in the standing army must be of especial value in the industries. An artisan who is cleanly, orderly, punctual, exact and disciplined, cannot fail to be an invaluable acquisition to a factory of any kind, and undoubtedly the success of the German industries in every branch of human endeavor is due to this class of well-trained laborers. This is a well-recognized fact in Germany, and similar views were expressed as early as 1893 by Dr. Caro, one of the greatest technical chemists of all times, who, in his classical description of the development of the German coaltar industry, published in the *Berichte der Berliner Chemischen Gesellschaft,* ascribed German superiority to the character of the workingmen who had served in the army.

German militarism early recognized the fact that the life and health of the laboring class are an important factor in the resources of the country, and consequently legislation for the protection of industrial workers has been evolved, which has become the pattern for all nations of the world. Even our own country which we think so free from militarism, has benefited by this German legislation, and when Governor Glynn of the state of New York, in becoming a candidate for reelection, reviewed what he had accomplished for the people during his term of office, he considered the Workingmen's Compensation Law as the most important of the measures passed during his incumbency. These compensation laws, together with the old age, accident, sick and death insurance laws, safeguarding and improving the economic conditions of the workers, are directly due to German militarism in its endeavor to husband the strength and earning power of the individual members of the industrial army. Even Lloyd-George, the arch enemy of Germany, copied these legislative measures of German militarism for the benefit of the laborers of England. To this constant care for the individual health and betterment of the working class are also due the establishment all over the Empire of government and provincial homes for convalescents, of homes in which persons suffering from incipient tuberculosis are treated, and of many other institutions with the object in view of promoting the recovery of those stricken with sickness.

These in a general way are the benefits which the industries of the

country have derived from German militarism. Specifically, we note its greatest influence in the agricultural conditions of the country, an influence which is perhaps best expressed by the phrase "the balancing of the interests of agriculture and industry."

German militarism soon realized that in time of war the nation cut off from all supplies will have to feed not only its army but also its population. For this reason, special efforts were made to foster agriculture. On general principles, industry and agriculture are sworn enemies. Industry wants cheap food for its workers; agriculture wants high pay for its products—meat and cereals. It is one of the greatest achievements of modern Germany—and this is especially due to Emperor William II.—that these ever clashing interests were reconciled, and that they were made to see that for the common good compromises concerning taxes, duties, etc., must be adopted, under which both industry and agriculture could prosper. Hence, a give-and-take policy resulted, which has accomplished the greatest good for the greatest number, and has elevated agriculture to such a flourishing state that the feeding of the German people to-day is independent of foreign produce—quite different from England, where agriculture was sacrificed at the altar of the industry and where the soil was so outrageously neglected that the nation depends for its food supply almost wholly upon the importation of meat, flour, eggs, cereals, etc.

To bring about this magnificent result in Germany, agriculture was forced to produce as much as the soil could possibly bear, and consequently farming became intense. Cultivation of the soil, the feeding of animals, etc., became a science. Other sciences, especially chemistry and botany, contributed to the culture of plants adapted for the varied conditions of the climate and soil of the empire. Seeds were developed and improved to a marvelous extent. While the sugar beet at the beginning of the last century, when the manufacture of beet sugar was started, contained only about 4 per cent. of sugar, the quality of the seed was gradually so highly improved that they now produce beets with over 22 per cent. of saccharine contents. This seed is exported all over the world from Germany, and during the present war one of our greatest worries is that we may not obtain this excellent material from Germany in time to prepare our next year's crop.

The cultivation of potatoes, which were originally introduced into Germany from the United States, has been brought to such a wonderful stage of development that two distinct classes of potatoes are raised, the one rich in carbohydrates but poor in nitrogenous matter for the fermentation industry, and the other rich in nitrogenous matter for eating purposes. Curiously enough, seed potatoes are now imported *into the United States* from Germany because our farmers allowed this vegetable to degenerate to such a degree that it has substantially lost all value for seeding.

The science of fertilizing achieved the amazing result that Germany's soil, although cultivated for almost two thousand years, is to-day more productive than the virgin soil of the United States and Canada. Deserted farms like those of the New England States and the state of New York are unknown in the Empire. Chemistry is not only educating the farmer in scientific fertilizing but producing the requisite artificial fertilizers, and here again German militarism in its farsightedness has brought about most astonishing revolutions.

Of greatest importance in agriculture are nitrogenous fertilizers, that is, artificial manure which introduces nitrogen into the soil. The chief material for this purpose is nitrate of soda, which, as saltpeter, is imported in large quantities from South America. Unfortunately, this substance is also the sole raw material for the manufacture of nitric acid, and nitric acid is the chief material for the manufacture of all kinds of explosives. The French and English employ picric acid, which is trinitrophenol (lyddite, melinit) and is made by the action of nitric acid on carbolic acid. The Germans are using as their chief explosive trinitrotoluol (tritolyl), which is produced from toluol, a coaltar hydrocarbon, and nitric acid.

German militarism realized that two great dangers might arise from these applications of saltpeter. In time of war the importation of saltpeter might be stopped by the navy of a foreign nation, and it might therefore become impossible to manufacture nitric acid and explosives. The feeding of the nation might be interfered with, inasmuch as the soil could not be properly fertilized, and hence could not produce sufficient food-stuffs. Therefore, it became imperative that the nation must become independent of the importation of saltpeter.

The problem was solved by the utilization of nitrogen from the air, and in this way nitric acid was produced without saltpeter as a starting material. Unfortunately, however, the available processes can be carried out economically only in localities where cheap power is available, which to-day means countries where water power is abundant. Since Germany has hardly any waterfalls, and therefore is very poor in power created in this manner, the plants for the manufacture of nitric acid by utilizing the nitrogen from air were mostly established in Norway—a foreign country. The problem was therefore only half solved. But soon by the direct union of nitrogen and hydrogen, as accomplished by the ingenious synthesis of Haber, an absolutely independent source for nitrogenous fertilizers and nitric acid was created within the German Empire. The raw materials for the Haber synthesis—nitrogen from the atmospheric air and hydrogen from water gas—are obtainable in unlimited quantities in the country. In the Haber synthesis ammonia is first produced which, in the form of the sulphate of ammonium, is as efficient a fertilizing material as saltpeter. This method, however, has

the disadvantage that the ammonia must be converted into nitric acid by processes which are not yet completely worked out. Undoubtedly, however, the economical manufacture of nitric acid from ammonia will soon become an accomplished fact, as recent publications seem to indicate that the problem is almost solved. During the present war all the saltpeter in the German Empire has been requisitioned by the government for the manufacture of nitric acid and the production of ammunition, while sulphate of ammonium obtained by the Haber synthesis and that recovered from the by-product of the coking industries takes its place for fertilizing purposes. The output of the existing Haber plant was doubled at the beginning of the war in order to provide sufficient sulphate of ammonium for the coming crops, and it is said that since that time another unit is in course of construction which will definitely secure Germany's requirements for nitrogenous fertilizers.

Another great benefit which, while the war lasts, will accrue to German agriculture from scientific farming is that the large acreage devoted to the cultivation of the sugar beet—usually the most fertile soil—will be *directly* available, without the use of additional fertilizers, for the raising of rye, oats, potatoes, etc. During the war Germany will not be able to export beet sugar which she does at other times on an extremely large scale, and will, therefore, not raise so many sugar beets. Utilizing this fertile soil for cereals, potatoes, etc., means an additional supply of food stuffs for the nation.

The industry for the recovery of the by-products from the coking process, which we already mentioned as a source for sulphate of ammonium, has also been highly developed because German militarism needed some of the resulting coaltar products for the manufacture of explosives. Benzol, toluol, carbolic acid, metacresol and diphenylamine are starting materials used in the manufacture of ammunition. Formerly, most of these substances were imported from England, where they were produced from coaltar obtained in the manufacture of illuminating gas by the distillation of coal, while in most other countries, for example, in the United States, illuminating gas is made from water gas. By developing the coking industry, that is, by suitably and economically heating coal, Germany has made herself independent of England, and now produces all the materials required for explosives and ammunition within her own borders.

Germany is also the only country which has made itself independent of England as far as its consumption of carbolic acid, one of the most important coaltar products, is concerned. This substance, employed both for explosives and as a disinfectant in general hygiene and surgery, is a material of war of the highest value. It was not considered wise nor profitable to remain dependent on foreign sources for such an indispensable article. Soon the ever watchful and resourceful chemist

found artificial methods for its manufacture, employing domestic raw materials. To-day several German factories have installed plants to produce carbolic acid by the action of sulphuric acid on benzol and subsequent treatment with alkali. Whenever the price of coaltar carbolic acid rises beyond a point at which synthetic carbolic can be profitably manufactured, these plants are put into operation. They are promptly shut down when the price decreases.

German militarism, by initiating and promoting the everlasting battle between armor plates and armor piercing projectiles, also conferred great benefits on the industry and on mankind in general. We all know that as soon as an improvement in the manufacture of steel was made which allowed the production of armor plate of great resistance, the chemists and engineers evolved a projectile driven by powder, which would pierce such an armor. This fight is still on!

Instead of carbon, which originally was added to iron to produce the iron-alloy called steel, we now use nickel, chromium, tungsten, molybdenum, vanadium, manganese and silicon, which enable us to manufacture refined steel possessing varied properties. Most of these additions in order to give the desired results must be in the state of highest purity. These substances which at first seemed of no use in any other industry were produced primarily to fill the requirements of the manufacturers of cannon, projectiles and armor plate, and the largest maker of these elements in the pure state is the firm of Th. Goldschmidt, located in Essen, where it is able to work in close union with the Krupp Works.

By these modern improvements wonderful materials were placed at the disposal of the industries. The hardness of steel has been so increased that for safety vaults and safes an alloy is made which can neither be drilled nor exploded nor cut by the oxy-hydrogen flame. The chemical industries have been supplied with refined steel which is not attacked by acids, not even by boiling "aqua regia," while other modifications are not affected by hot caustic soda. Some of them are non-magnetic, others are unaffected by atmospheric influences, or exhibit great resistance to electricity, while some possess high tensile strength. They are thus of specific value in the manufacture of automobiles, of steam turbines, of electric appliances, of rails for electric tramways, of dynamos, motors and transformers.

Vanadium steel furnishes our modern tools, which are distinguished by extreme hardness, and here a war on a small scale is going on between structural steel and steel for tools with which to work the former. Every improvement in the hardness of structural steel must of necessity bring about the manufacture of a still harder steel for tools, exactly as in the case of armor plates and armor piercing projectiles.

German militarism has also benefited the industries in a field where

its activities could hardly have been expected. We refer to the manufacture of hydrogen and oxygen. Strange to say, these two gases which had never found any industrial application, although known since the birth of chemistry, have lately become of the greatest technical importance and are to-day manufactured on a tremendous scale. Hydrogen is used for military purposes in immense quantities for all lighter-than-air flying machines—the filling of Zeppelin ballonettes, the filling of captive balloons, which have become of such great importance in modern warfare, being constantly employed by the staffs of the armies for observation of the battlefield. By telephone and photography they are in constant communication with headquarters.

The cheap and practical methods which were evolved by the military authorities for the generation of hydrogen are now utilized in one of the industries which has recently become of the highest importance, namely, the manufacture of what is called "hardened oils and fats." By treatment with hydrogen, oils and fats in the liquid state are converted into solid materials, which usually command a higher price for technical purposes, such as the manufacture of soap, etc.; and low class fatty substances, which are not fit to be eaten on account of their appearance or odor may be transformed into valuable food materials. By the economical manufacture of hydrogen, which makes it possible to utilize such inferior goods for alimentation, German militarism again deserves well of the nation. It must also be noted that the cheap production of hydrogen is one of the prominent features in the above mentioned manufacture of sulphate of ammonium according to the Haber process. Thus the manufacture of hydrogen, while originated for military purposes, is helping to feed the nation by providing new edible substances, on the one hand, and a new source for fertilizers, on the other.

The manufacture of oxygen likewise assumed gigantic proportions, after it was found that armor plates could be cut almost like butter by the heat of the flame from a burner fed with a mixture of hydrogen and oxygen, or oxygen and acetylene gas. At present, not only the cutting but also the welding of iron and steel is accomplished by means of such a flame; every machine shop is provided with an oxygen apparatus, and soon every garage will be similarly equipped, as it has been observed that the carbon collected in the cylinders of gas engines for automobiles, etc., can be easily removed by burning it out with the oxygen-flame.

The oxygen problem also plays an important part in the running of submarine boats where it is necessary to provide the crew with oxygen for breathing under particularly difficult circumstances. It is stated that nitrogentetroxide, a gas which can be easily compressed to a liquid, and which, when appropriately heated, decomposes with the liberation of oxygen, has been employed for this purpose with great success. But for the necessity of supplying oxygen to the submarine boats, this sub-

stance—until now largely a chemical curiosity—would perhaps never have been thought of for any technical purpose. Undoubtedly many other industries will avail themselves of this new source of oxygen under conditions similar to those on submarines, for example, for diving operations, in mines, for caisson work, etc.

Militarism in the search for new explosives discovered guncotton and thereby started the "nitrocellulose" industry. While guncotton made by the treatment of cotton with nitric acid proved to be an almost uncontrollable explosive, it was soon found that by a less energetic action of nitric acid on cotton, substances could be produced which were practically free from any danger of explosion. These lesser nitrated cotton products became the starting material for the celluloid industry in all its interesting and important branches. Besides furnishing various well-known household articles, billiard balls, etc., and substitutes for ivory and tortoise shell, celluloid became the base for a class of very valuable varnishes. It made amateur photography possible by the substitution of sensitized celluloid films for the breakable and heavy glass plates, and it provided humanity with its greatest agent of amusement and instruction—the moving picture show. But as the lesser nitrated cotton substances in celluloid, like all nitro derivatives, were not yet absolutely free from explosive risk under certain conditions, persistent efforts were made to find safe substitutes for them. Lately these experiments were carried to a successful termination, and acetylcellulose obtained by the action of acetic acid on cotton has replaced the dangerous nitro products, especially in the manufacture of non-inflammable films for moving pictures—a material in which the absence of danger from fire is obviously of the highest importance.

This acetylcellulose is also of distinct value in the manufacture of a varnish which finds its largest application in the construction of flying machines where its particular properties are of signal service. What a brilliant record of achievement in the search of militarism for a new explosive!

Militarism has also solved the problem for the textile industry as to which colors are most conspicuous and which least visible. Exhaustive tests showed that uniforms of a peculiar grayish-green shade rendered the soldier practically invisible in the field. How correct these observations were, was demonstrated at the start of the war when it was reported that the presence of the German troops was not noticed by the enemy at distances greater than two hundred to two hundred and fifty yards.

The most conspicuous color in all kinds of light was found to be red on white or white on red. This fact was made use of by the German advertising men who now paint their posters, etc., mostly in red and white, and also by the municipalities of German cities which are using

red and white surfaces for sign-posts in their street. How peculiarly unfortunate for the French soldiers with their red trousers that they could not avail themselves of the result of these tests!

These few instances, which could be multiplied indefinitely, will suffice to demonstrate the correctness of my contention as to the manifold benefits conferred upon industrial development by militarism.

Evidently, therefore, German militarism is not the horrible institution which the English try to make us believe it is. It suits the German people, and it has made Germany one of the most powerful and prosperous nations, and enabled her to compete successfully in commerce and industry with the richest countries in spite of the lack of almost all crude materials, the natural resources consisting only of coal, iron and potash salts. Compare this with our country, which abounds in gold, silver, copper and practically all other metals, besides furnishing cotton and petroleum to the whole world. Yet as the result of wise legislation, incredible thrift and economy, the cooperation of science and technique, and thanks to its militarism, the standing army and general conscription, Germany has reached a most enviable position among all industrial and commercial nations.

German militarism is not the arrogance of a military caste whose intrigues lead to war. To its salient features—compulsory service and the standing army—Germany owes its organized industrialism, which has made possible not only the efficient defense of home and family, but the mighty victories gained by the nation in manufacture, commerce, the arts and sciences. German militarism ultimately means progress along the whole line—law, order and justice.

HOPE FOR THE RUSSIAN PEASANTRY

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IT was in the district of Kineshma on the Volga that I first saw that suggestively pitiful sight, thin-growing grain cut by hand. A toil-worn peasant woman, her head covered with a scarlet kerchief, her body bent, grasped the stalks in one hand and cut them with the sickle held in the other. She seemed the embodiment of that patient acceptance of a hard destiny so characteristic of the Russian peasant. It was evening, and the meager results of the day's work lay heaped up in less than half a hundred bundles lying in a line down the narrow field. The ribbon of stubble, only a few yards wide and hundreds of yards long was one of many that lay parallel and stretched almost as far as the eye could see, separated from each other by shallow ditches or rudely heaped-up earth. There were other strips of light yellow rye, of darker yellow barley, of reddish-brown buckwheat, of green hemp.

Further on lay a second set of narrow strips almost at right angles to the first. Searching the landscape I discovered that except for the low-lying meadows, patches of woods, and the village on the high bank overlooking the river, the surface of the country was divided into innumerable bands all long and very narrow, grouped together evidently according to some principle as yet unknown to me. Later I learned the meaning of these minute divisions and found its roots in the past.

Previous to 1861 the Russian peasants were serfs. Except for those who did duty as household servants, they were bound to land which belonged to their masters. Those thus bound, by far the greater number, spent a part of each week in cultivating the estates to which they belonged, and the remnant in working their own fields upon which they were dependent for bread. When these serfs were liberated each village or group of villages was given a certain amount of land in communal ownership, the price to be paid in forty-nine annual installments called redemption taxes. The community was held responsible by the state for all dues. It could cultivate the fields in common, using what was necessary of the harvest for these payments and dividing the rest among its members; or it could parcel out the fields and demand from each family a part of the total sum due the state proportionate to the value of the land allotted to the family. In the latter case the amount of land given to a family was ordinarily determined by its working strength, by the number of grown sons, for instance, able to help their father till his fields. The essential thing in the eyes of the community

was that strict justice should prevail, that the ratio between the value of the land held and the annual payment made by the family should be the same in every case. The *nadiel,* the land acquired by the community when emancipated, was, therefore, divided into units of equal value, one or more of these units being assigned to each family.

There were three principle methods of division and all of these resulted in cutting the land up into minute parcels. It may be interesting, by way of illustration, to consider in detail the method which was followed, for the most part in central Russia. The *nadiel,* leaving out of account pastures and woods which were ordinarily held in common, was first divided into three fields to provide for a rotation of two different kinds of grain and fallow. Each one of these fields was then divided with reference to quality. Areas of good black loam, of sandy, clayey and other kinds of soil were carefully delimited. Each one of these areas was then divided into a fixed number of strips equal to the number of units needed at the time by the community. Each unit contained one strip of every kind of soil in each of the three fields. The number of strips in a unit was comparatively few in lands of uniform quality and many, fifty, eighty, one hundred or even more, in lands that varied much. In any case it was certain that each unit possessed exactly the value of every other unit. Here was justice but at what a price! Land cut up into such bits that it could be tilled only with the simplest implements, endless time lost in going from one parcel to another, sameness of crops necessitated by the fact that all must sow and all must reap at the same time. More often than otherwise the only approach to a strip was across other strips. Once these had been seeded they barred the way. The absence of fences made it impossible to plant anything that would mature after the neighboring fields had been cut. The cattle having been turned into the stubble of these fields would eat the adjoining not yet ripened harvest. And what soil rendered utterly fruitless in boundary lines, the furrow used to separate the strips being sometimes one fourth as wide as the strips themselves.

For long years the Russian *mujik* was slow to grasp these disadvantages. He was used to community life. He liked doing what his neighbors did. Why not all plant rye and buckwheat? Did they not all eat black bread and *kasha?* What better than hemp and flax for the weaving of household stuffs? The fields were a long way off—yes, but it was God's will, and one must be willing to harness the horse to the *teléga* and begin the five mile journey at break of day. And when one grew hungry and thirsty there was the loaf brought along and the keg of water hung on the hooks at the back of the wagon. True the fields were sometimes so far away that it was necessary to spend nights there, but the earth was a good place upon which to sleep, the baby's crib could be suspended from two poles fastened in the ground and the mother and children could help gather the precious kernels. Such sights are

not uncommon in Russia to-day and are true to the past in nearly every detail. The Russian peasant accepts with scarcely a murmur what he believes can not be changed. He is not likely even to question circumstances if he has bread enough.

And during the period immediately following the emancipation it would seem that there was for the most part bread enough. There were hungry years even then, when the crops were poor or failed altogether, but they were taken as a matter of course. No one was held to blame. The peasants complained, it is true, at the necessity of paying for the land which they firmly believed had always been theirs, but the pressure of poverty was not yet such as to drive them to seek a remedy.

Time, however, brought changes. Sons and daughters grew up and married. Whether they remained in the home of their parents or built *izbas* for themselves land must be provided for them. How else could they live? But new units could be created only by dividing the fields anew and every parcel was thereby made smaller. Now and then, indeed, the community leased private land, but the rent was a difficult problem. Occasionally, also, alas! it was obliged to lease out some of its own land for money paid in advance and imperatively needed for the annual dues. Ordinarily this was a tract worked in common, not parcelled out into lots, but its alienation decreased none the less the food supply of the village. Thus the time came when the *nadiel* did not yield enough to support those who cultivated it. They were obliged to eke out a livelihood by earning money during the winter. Sometimes a whole village made nails, or carved wooden spoons or painted icons. Often the men sought work away from home. Some of them wandered from place to place, accepting any employment that offered itself, living most meagerly, saving every *kopec* and bringing back with them in the spring perhaps forty rubles apiece, little more than twenty dollars. Some went to the city and became cab-drivers, household servants of one kind or another, porters in railway stations. It often happened that all the men of one village who left home to earn money went to the same city and engaged in the same employment. Those whose services were not required to cultivate the land apportioned to their families frequently stayed throughout the year, sending their earnings back to help pay the dues to the state, comforting themselves in their exile with the thought that in old age they could return to the land and depend upon it for a livelihood. To return to it and share its fruits was certainly their privilege. Every *mujik* family recognizes the right of its own to come back, but the amount to be shared grew ever smaller.

As the years passed and the Russian peasantry increased in numbers by leap and bounds, doubling itself in less than half a century, its lot became constantly worse. The loaf scarcely large enough for four is scanty food for eight. Small wonder that very many of the communities were quite unable to make their annual payments to the state. Others

managed to do so only by selling their entire harvest and even their horses and cattle. The misery into which they were plunged may be easily imagined. Nearly every year in some one region or another thousands perished from slow starvation.

The government of Russia has been many times arraigned, and justly, for its apathy in the face of such conditions. Doubtless it did not wholly understand the situation. The country was vast, roads poor, and communication slow and difficult. There was, moreover, a great gulf between the world of officials and the peasants bridged over only by the *zemstva,* councils of the district and province. One circumstance, however, certainly known to the government since it touched its purse, should have prompted an investigation—the ever-increasing inability of the peasants to pay the redemption money. The government did offer some slight relief. In 1881 it lessened the taxes, particularly in the provinces whose arrears were greatest, in 1882 it established the Peasants' Bank, the chief business of which was to assist the *mujik* to buy land from those willing to sell, generally owners of large estates. The activity of this institution, however, was not great during the first thirteen years of its existence. The conditions on which the bank was permitted to lend money were such that the peasants could not for the most part profit by them. Some transference of land to peasants did take place but not enough to better the situation appreciably. The *zemstva* made laudable efforts to spread information concerning rotation of crops and enrichment of soil, but the results were merely palliative. The end of the century found matters even worse than before and in the southern part of Russia the misery and unrest among the peasants assumed a threatening aspect.

The fear of revolution is a powerful stimulus. In this case it led to the creation in 1902 of a special Council of Rural Industry to study the agrarian situation in its various aspects. Some members of this council were placed in every district of every province and there joining to themselves representatives of the gentry and the peasants of the district inquired carefully into conditions in the immediate vicinity. This investigation resulted in a mass of valuable data and some recommendations, which, be it said, those highest in authority did not wholly relish and which were not adopted. Then in 1904 came the Russo-Japanese war, which distracted the attention of the government from home difficulties while it increased the misery of the people and their ire against the state. The result was great and wide-spread peasant disturbances. Private estates were laid waste and the rioters made ready to seize the soil which they firmly believed to be their own. It was imperative that something be done at once.

In these circumstances it is not at all strange that the government should have read the situation as most people in Russia read it. The

peasants saw no remedy for their plight but more acres, and the various political parties differed chiefly as to ways and means of providing them with this desideratum. The first *Duma* had advocated the forced expropriation of all crown, church and private lands, and its steadfast adherence to this demand had brought about its dissolution. But while the government disapproved of this method of supplying the need of the peasants, it felt the need to be a real one. It therefore increased the powers and privileges of the Peasants' Bank so that through its medium the poor could add to their holdings on surprisingly easy terms. Appanage lands were offered for sale. Large areas of private estates whose owners had suffered in 1905 and who feared further disturbances were placed on the market. During the five years from 1905 to 1910 inclusive, more than 14,000,000 acres were sold to the people through the agency of the bank. These figures sound large. They are, however, relatively small. Moreover, it must be remembered that in those very districts where the cry for land was loudest there was in the nature of the case least to be had.

Meanwhile, however, the government attacked the agrarian problem from another side. The *ukase* of November, 1906, was meant to induce the peasants to change from communal to private ownership. This had been their privilege on certain conditions according to the laws governing the emancipation but in 1893 the privilege had been made subject to the consent of the *mir,* the village community, because at that time the government did not wish the strength of the *mir* to be impaired. The *ukase* restored the privilege, but whereas in the past the peasant had seldom been able to avail himself of it because he had not the money to buy out his land from the community now he had no need of money since the government cancelled all arrears and all redemption installments payable in the future. Any member of a *mir* could step out whether the *mir* were willing or not, receiving his due amount of land in private ownership. How much the individual received depended upon circumstances. If he had held the same parcels for twenty-four years, in other words, if there had been no redistribution of the *nadiel* during that time, he received these parcels or their equivalent, the assumption being that in that particular community the principle of parcelling out the land was dead. If on the contrary there had been a redistribution of land within the last twenty-four years, the assumption was that this principle was still operative. In that case the withdrawing peasant could claim only as much land as would be allotted him if a redistribution were made at the moment of his withdrawal. He must be allowed, however, to purchase the difference between what he actually held and what he would receive in the event of a redivision.

This law definitely announced the break-up of the *mir,* it looked toward the end of community ownership. It had, in all probability, as

its immediate object the formation of a class of small proprietors who would be loyal to the state, moved by gratitude for the property rights granted them and the desire to retain those rights. Even small property owners are in general on the side of law and order and against that anarchy which destroys real wealth. Doubtless, also, the government felt that so long as the peasants held land in community ownership they would act as communities in other matters; and when it came to an expression of grievances it could more easily deal with individuals than groups.

It may be questioned whether the mere transition from communal to private ownership held in itself any salvation for the starving peasantry. If the land remained split up into tiny parcels, it was a matter of little moment whether the title lay with a group or with an individual. About 18 per cent. of the *mujiks* already owned their land in perpetuity. Exact statistics dealing with the subject are lacking, but it would seem that these were for the most part no more prosperous than their communistic neighbors. Some of them had so little land that they were of necessity very poor. Having been offered in 1861 their choice between a certain number of *dessiatines* at a fixed price and one fourth of this amount as a gift they had chosen the latter alternative. Others had bought their shares from the community but received them for the most part in such small parcels that they could not be worked to advantage. Private ownership, therefore, where known, did not always wear an alluring garb. In many places it was wholly unknown. Communal ownership, on the other hand, was an old institution, generally prevalent and deeply ingrained in the people. They saw in it safety for themselves and for their posterity. So long as the village continued to own the soil there was a bit for every man and for his sons and grandsons.

In the light of these considerations it is not strange that the great bulk of peasants were not inclined to take advantage of the new law. There were, however, two classes to whom it appealed. One was captured by the clause which provided that the family whose holding was larger than it would be, were a redistribution made now, might buy, at the price attached to this land in 1861, the difference between what it held and what it would receive in the event of a redistribution. Land having trebled in value during the last half century, such a family would of course profit greatly by a purchase on these terms. The other class was made up of those peasants who held parcels of land as members of a community but who had taken up their abode in some city or industrial center. Such were glad to receive their parcels in private ownership because they could then sell them. Aside from these two classes, there were of course some *mujiks* who seized this opportunity of getting compact farms, which, being their own, they could work as they pleased in

a scientific way. These were comparatively few in number. It must be confessed, then, that the *ukase* of November, 1906, did not in itself provide a salvation for the economic difficulties of the people.

A solution was, however, bound up in a way with the working out of the law. Its execution lay with the provincial and district commissions created in 1906 primarily to assist the Peasants' Bank in smoothing the way for those who wished to purchase land. Now the bank had been definitely instructed to sell its land as far as possible in well-rounded pieces which in the hands of individual owners might serve as models to the neighboring communities. The commissions were therefore, while assisting the bank, engaged in the creation of compact farms. Their other activities were along this same line. They were instructed by the government to do everything in their power to persuade the peasants to give up irrational methods of cultivation, particularly the division of the fields into minute parcels.

The *ukase* of 1906 gave these commissions a great opportunity. The law did not state that every peasant who wished to withdraw from the community and receive his share of land in perpetuity must be given that land in a single piece but it permitted and even encouraged this procedure and it was quite natural that the commissions should have striven toward this end in the surveys which they were called upon to make. During the five years from 1907 to 1911 inclusive 503,408 families withdrawing from the community received their land, through the agency of the government surveys, in compact units. This was certainly not a large number, considering the population of Russia—but it was a decided step in the direction of agricultural progress.

The *ukase* of November, 1906, then, although primarily political in its spirit and purpose, resulted in a certain limited economic good. From the very beginning there were some who defended this effort to transform community into private property on the ground that it paved the way for scientific farming. Gradually the emphasis shifted from the question of tenure to the question of husbandry. It was plain to those who studied the subject that the diminution of crops in Russia was due to obsolete and wasteful methods of cultivating the soil. There were whole areas that were exhausted, there were fields that lay so far away from the village that owned them that they could not be tilled, the weed-grown furrows which served as boundary lines between the parcels aggregated a vast territory lost to cultivation. The essential thing was to map out the land anew so that it could be worked in larger tracts and with better methods.

It might have been possible, as some contend, to legislate toward this end without disturbing the *mir*. The separate parcels could have been consolidated into large areas and still have remained communal property. This was done by some villages in central Russia during the

last decade. They cultivated these large tracts to advantage, using improved machinery. There is, however, much to be said on the side of those who insist that technical advance in agriculture can be furthered best in connection with private property. This is the assumption on which the law of June 1911 rests. There is in this law definite evidence of the change of emphasis in the land policy of Russia. The government still wishes to encourage the transformation of communal property into private property, but it brings less pressure to bear in this direction. On the other hand, it lays tremendous stress upon uniting the various parcels of land belonging to one owner, whether that owner be an individual or a community. The law makes the most elaborate provision for the settlement of every imaginable difficulty arising from the lack of clear demarcation of boundary lines and the confusion of tenures. There are areas in Russia which wear the aspect of a veritable puzzle—fields of different villages intermingled, church, state and private property enclosed in one piece of communal property, holdings partly communal and partly private and so on almost without end. Out of this chaos the government proposes to bring order—but only upon request. When a family, or a number of families, or a village, or a group of villages forming a community, desire to have their land surveyed and rearranged, they appeal to the district commission whose members represent the central government, the local government and the peasants themselves. This commission appoints one of its number, or a surveyor, to examine the locality in question and to confer with the petitioners as to their wishes. The entire matter having been explained to it, the commission decides whether the project is in harmony with the principles laid down by law to govern all the new land arrangements, and, according to its decision, either refers the project back to the peasants for changes, or orders that it be worked out in detail. When this has been done, those whose lands are concerned are requested to pass upon the plan in its final form. It is their privilege to accept or reject it, but every effort is made by the members of the district commission to overcome objections by persuasion or by practicable modifications. When accepted the plan is sent to the commission of the province. Upon the approval of this commission the work is put under way as soon as surveyors can be spared for it.

The character of the work done by these surveyors depends upon circumstances. A few illustrations will serve to make it clear. When the peasants were emancipated it often happened that a group of villages, being the property of one and the same lord, received their *nadiel* as one community. This land was not a single piece but was made up of many irregular pieces. Certain ones belonged to each village, had been cultivated by it in the days of serfdom. These were rarely continuous and were mixed with the pieces belonging to the other villages of the

group. Furthermore the *nadiel* often enclosed in its boundaries lands owned by the state, the church or private individuals. Suppose these villages request what is known in German as *Verkoppelung und Auseinandersetzung*—consolidation by means of exchange of land belonging to each village. It then becomes the task of the government surveyor to measure off the land belonging to the entire community and to give to each village in one piece, if possible, the equivalent of the many parcels belonging to it heretofore. The difficulties of such a task are apparent at first sight. The quality of soil may be anything from very good to very bad. It is necessary to fix a standard and then determine the value of each particular quality with reference to that standard. If the best soil is taken as the standard then it will require let us say 1⅛ *dessiatines* to equal one *dessiatine* of the best, 1¼ *dessiatines* of the next poorest to equal the best and so on down to the worst. The problem attaching itself to the division of the arable land among the villages being solved, there remain the questions of the meadows, the pastures and the woods. Each village will wish to have some grazing ground in its immediate vicinity even though its arable land should be far away. The group of villages may desire to continue to hold the meadows and woods in common. This arrangement was often made in the surveys of several years ago, but the government now distinctly discourages it. When the private lands strewn among the parcels of the community hinders the giving of a compact area to each village, then efforts are made to buy the offending pieces or to exchange them for outlying portions of the community land.

It must be understood that each village, being now provided with the equivalent in one tract of its many parcels, is still at liberty to regard the tract as communal property. It is under no obligation to divide it into individual holdings. But any family in the village may demand that its just share be given it in perpetuity, in which case the matter is either amicably arranged in the village, or is settled by government authorities. It frequently happens that a number of families, alert, ambitious and enterprising, make this request and transport their little homes from the village to their new farms which are then known as *houtors*. Curious it is to see, but not at all uncommon in Russia, four such families whose lands form approximately the four quarters of a square, building their *izbas* in the angles that meet at the center so that a few steps will cover the distance from the door of one house to the next. Even these pioneers dread living alone. The *mujiks* are gregarious. The opportunity for companionship is a prime requisite with them. And, indeed, quite aside from the matter of temperament, a family might well wish to avoid complete isolation during the long weeks when the melting of the snow and the spring rains render the roads impassable.

The government may be called upon to survey the *nadiel* of a single very large village. Take Borma as an example. It owned 6,250 *dessiatines* or approximately 16,625 acres cut up, so that each household tilled eighteen widely scattered parcels. The pasturage was divided anew each year and the ravines were held in common. One hundred and ninety-one families desired to have their holdings given them in private ownership, the rest wished to retain theirs in communal ownership. It was decided to divide the *nadiel,* so that the northern part might be given to those who wished to withdraw from the *mir.* Of the latter class ninety-nine families settled upon the tracts assigned them, ninety-two settled in eight groups upon sites purposely chosen at some distance from each other for villages. This arrangement was made for the benefit of those who felt it necessary for the sake of social intercourse to live in the near vicinity of neighbors yet who wished also to be relatively near their fields. Farms whose owners live in the village are known as *otroubs.* This arrangement is at present very common in Russia. Often it is doubtless an intermediate stage. In the course of time many families living in villages will move to their farms, provided they are able to find good drinking water there or in the near vicinity. The *mujik* does not mind carting his water in barrels over long distances but there is a limit to the time he can spend in this occupation. A single well frequently serves an entire village.

Here is another example of the kind of task the government may be called upon to perform. A village that has worked its *nadiel* in common since the time of the emancipation or that, while holding it in common, has parcelled it out periodically among its families, decides at a meeting of the adult men to go over to private ownership. The proper request is laid before the district commission and the surveys begin. The first question has to do with the roads. In central Russia particularly the old ones are meandering and very broad. Why take the trouble to fill in wagon ruts that have become hopelessly deep when it is possible to drive alongside of them? And when new ruts have been formed these, too, can be left to care for themselves. Thus the old roads lost whatever straightness they may originally have had and stretched to a great width. New ones must be carefully laid out. Next comes the question of water. It is the ideal of the government to persuade each family to live on the tract allotted it and with this end in view the commission frequently offers to assist the *mujik* with the money necessary to transport his old dwelling or to put up a new one, the sum to be paid back in fifteen years without interest, although occasionally in extraordinary circumstances it is an outright gift. Often, however, the absence of water or the expense involved in sinking deep wells makes it necessary for the peasants to live in groups. In this case sites must be selected for these so-called daughter-villages. Then comes

the differentiation of the different qualities of land. After that the tracts are laid out, each one as nearly as possible approaching a square, some perhaps entirely of plough land, some combining plough land with pasture and woods. The peasants who are to receive tracts of exactly equal value often draw lots for them. The assignment of other tracts is ordinarily made by mutual agreement.

It is difficult to comprehend what a vast amount of labor is involved in these surveys. In the single year of 1912 nearly 9,000,000 acres passed under the measuring-chain. More than five thousand surveyors are employed and paid by the government. The commissioners in charge of the so-called new land arrangements number seven thousand.

Well laid-out tracts of land are not, however, an end in themselves. They are simply the requisite for scientific farming that will yield the largest returns. The peasants of Russia must be taught how to manage their soil to the best advantage. This instruction is being given them. Agricultural experts have been stationed throughout the country to teach the *mujiks* by counsel and example how to dress and till their fields, what crop to plant. The number of these experts in the employment of both the government and the *zemstva* increased from 2,541 in 1909 to 5,185 in 1911. Many model farms and testing-fields have been established to make plainly evident the concrete results of better agricultural methods. The experimental stations increased from seventy in 1907 to two hundred and ten in 1911. I can speak from personal observation of one in the province of Samara. It is in charge of a gentleman who studied agronomy for two years in the United States and is excellently managed. Much should be said in praise of the work done by the *zemstva*. That at Kineshma is engaged in a great variety of admirable activities all looking toward the welfare of the peasant. I need only mention as àpropos of agricultural progress the placing of stallions where they will help toward breeding finer horses and the furnishing at little more than cost price of excellent seed and farm machinery of every kind practicable and desirable in that part of Russia. Many other *zemstva* are engaged in the same work. Indeed these district and provincial councils were the first to conceive the idea of teaching the peasants how to improve their methods of cultivating the soil. That was twenty years ago, more or less; now the government is co-operating with them and added stimulus and strength have brought corresponding results.

The new land policy of Russia is scarcely known to the world at large. Considering its magnitude and importance very little in the way of a careful exposition of it has been written. Yet it has to do with more than 100,000,000 people and with an area almost equal to the rest of Europe. It endeavors to change in a decade or two the habits, customs, ideas and ideals of centuries. While the reforms of Peter the Great were limited almost entirely to the upper classes, this concerns

itself with the masses. It seeks to lift them from poverty into comparative well-being. It is theirs to seize the opportunities offered them. As they do so they will enter upon a new life.

There are those in Russia who point to the many mistakes made by officials and surveyors in the execution of this land reform. It is true that in the beginning the work was pushed so rapidly that it was not always well done. There was a dearth of good surveyors and the government was often obliged to make use of those inadequately prepared. Roads were not always well placed, possibilities of obtaining good drinking water were not everywhere thoroughly investigated and peasants withdrawing from the *mir* were allowed to retain meadow and pasture land in common. The mistakes of the first years are certainly to be deplored, but it must be recognized that they were almost inevitable in so vast an enterprise. Now, however, the various district and provincial commissions have profited by their experiences and are directing operations more wisely. Certainly there is in the higher commission to which they are responsible one man fitted in every possible way to inspire and direct the great undertaking. I refer to Mr. A. A. Koefoed. He was connected for many years with the Peasants' Bank. He traveled widely in Russia studying at first hand the question of land tenure and the prevalent methods of cultivation and has become the most eminent authority on this subject. Moreover, he understands the *mujiks* and knows how to meet them and is heartily desirous of furthering their best interests.

Again there are those who say that this policy of the government will bring only temporary well-being. In less than a century the peasantry will be as badly off as ever. The family provided with land enough to yield it a livelihood now will divide this land among its children and so rapidly do the *mujiks* increase in numbers that it will not be long before their farms will be so small as to throw them back into indigence. This assumes that the children of all those now tilling the soil will also till the soil, a supposition which is scarcely tenable considering the ever-increasing demand for laborers in industry. It would be well, however, to take some precautionary measures against the contingency of redividing the land into small parcels. Denmark has enacted an inheritance law which fixes a minimum size for farms. If Russia were to do the same no peasant could divide his freehold between two heirs unless it were at least twice the size of the minimum. The farm incapable of division could be left to one of the children, this one to make good the shares of the others by money payments, a practise which prevails in Norway and in certain parts of Germany. There is, however, very little occasion to fear that the sizable freeholds of to-day will in the future be divided into minute parcels. Rather it may be confidently expected that the number of small freeholds will steadily de-

crease. Many peasants have been obliged to mortgage the land which they had in order to purchase more. Some of these will find themselves unable to meet their obligations and will sell or lose that land. This may happen as the result of incompetence, inexperience in the management of private property, poor harvests or other calamities. On the other hand those peasants who are shrewd, thrifty, hardworking, fortunate, will prosper and will add to their *dessiatines*. The march of time, then, bids fair to divide the rural population of Russia into two classes, the one landless, dependent upon wages for a livelihood, the other made up of small, well-to-do landowners.

This probability, not to say certainty, has raised other voices against the new land policy. These maintain that the increase of a landless class, a proletariate, is always a bad thing. It is not proposed to discuss here the general question of the right of each man to a bit of soil large enough to yield him a livelihood. It need only be pointed out that this ideal can not be realized in Russia. Even if every *dessiatine* in that vast country were given to the peasants, in much less than a century the holdings would again be too small. Poverty would once more reign over the people. On the other hand it is possible for the proletariate to be self-respecting, intelligent and prosperous. The opportunity for wage-work is not lacking in Russia. There is to-day a demand for laborers on the large estates which can not be satisfied. Great losses are annually sustained by them because there are not hands to gather in the harvest at the proper time. Factories, too, suffer from the lack of operatives who will keep at their tasks the year around. They are too often dependent upon those who leave their farms in the fall to return to them again in the spring. This demand is steadily growing since manufacturing is greatly on the increase.

Certainly the augmentation of the proletariate is not an unmixed good either for those who constitute the class or for society at large. Work is not always to be had for the asking and returns are often inadequate and uncertain. Then, too, there are the dangers inherent in leaving an environment that has exercised a restraint and set up standards and entering another in which one has at first no fixed place and no social responsibility. In time, however, the new environment will become an old one with a conscience and with rulings of its own. Moreover in the long run much good may be expected from separating the individual from the community and obliging him to stand alone. Unsupported by the props to which he is accustomed he will stumble, he may fall, but when he rises it will be with a new strength all his own.

And what of the other class whose numbers whether through superior intelligence or industry, fortunate circumstances or a combination of all these are able to add substantially to their lands. Certainly it has not yet come into existence as a body conscious of its solidarity,

able as a whole to work definitely toward chosen ends. Time and experience and education are necessary for that. But individual well-to-do *mujik* families grow steadily more numerous. I remember in particular one such in the province of Samara. Its past, its present, its future were, so to speak, plainly in view. I drove up the hillside through fields of golden grain, past the tiny orchard not yet old enough to bear fruit, to the brand-new home, each one of the four good-sized rooms fully furnished and so orderly and immaculate as to show conclusively that they were not being used. Scarcely ten feet back stood an old *izba* bearing every evidence that the family lived its life there. The back part of the stove and a low platform served as beds. Sheep-skin coats and long felt boots lay heaped in one corner. Hens walked placidly in and out of the door and the horses and cattle were stabled only a few feet away. Our host displayed his possessions with the greatest pride and pointing significantly to a field adjoining his own said, "It will soon be mine. I am buying it." It is probable that this man will not be content to have his children attend only the parish school. Some one of them may be sent away if only to study how better to till the soil and make it yield larger profits. Here is the new agricultural Russia from which great things may be hoped. These well-to-do farmers, sobered by the possession of property, no longer obliged to labor for bread to the exclusion of everything else, able to educate their children, will rapidly rise to the position of a powerful middle class to whose united voice even autocracy will listen. If this class is able to preserve the remembrance of its kinship with the poor, if it deals as justly with all strata of society as the communes from which it has sprung sought to deal in the distribution of their land the future of Russia is assured.

THE WAR AND THE WEATHER DURING THE FIRST THREE MONTHS OF THE FIGHTING

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WAR and the weather seem, at first sight, to have no relation to one another. Set in motion by human forces apparently far beyond the control of our ordinary physical surroundings, military campaigns seem likely to go on unaffected by such more or less "accidental" conditions as cold or heat; rain or snow; wind or cloud. Yet all through human history, as far back as we can secure accounts of wars and of military campaigns, the weather element stands out as one of the great controls, a control to be reckoned with by every commander, and one which, when powerful enough, has had consequences of far-reaching historical importance. The weather factor in war is not a joke. It is a perfectly serious subject for study on the part of military and naval strategists. It must be taken into account in laying out a campaign or in organizing troops for a battle. To disregard the weather factor in warfare is almost, if not sometimes quite as serious an omission as to forget to provide food, or clothing, or ammunition. The weather has, time and again, turned the scale, for victory or for defeat. Written large in history, as events of the greatest significance, we have the retreat of the Turks from Vienna in 1529, their siege artillery having been left behind in Hungary on account of heavy rains which made the roads impassable, and the besieging army being hampered by inclement weather and by the scarcity of provisions, which were both difficult to secure, and almost impossible to transport. All three of the Spanish Armadas (1588, 1597, 1719) suffered from hostile winds and storms. In 1719 the Spanish fleet was scattered off Cape Finisterre by a violent storm which raged for twelve days. Only two ships succeeded in reaching the coast of Scotland. To take an illustration from our own early history, the closing chapter in the evacuation of Boston by the British would probably have been quite different if a severe storm had not frustrated General Howe's plans. The Americans had begun the fortification of Dorchester Heights during the night of March 4, 1776. The morning of the 5th dawned clear and mild, with a bright sun and a warm southerly wind. General Howe and Admiral Shuldham, realizing that their own positions were insecure as long as the Americans remained on the heights, sent between 2,000 and 3,000 men in transports across the Bay, the plan being to have them land and attack the enemy in the rear. But a violent

storm, which began during the afternoon, drove three of the transports ashore on Governor's Island. The rain fell in torrents. There was no abatement of the storm on the following morning (March 6), there being a furious gale from the southeast which caused such a surf on the Dorchester shore that "an attempt to land (on the part of the British) must have proved fatal." The Americans continued to fortify in spite of the storm, and when the weather had improved sufficiently for the British to attack, they realized that the American position was too strong. By night of March 6 the evacuation had been decided on. General Washington wrote on March 14: "A very heavy storm of wind and rain frustrated their design." The terrible winter retreat of Napoleon's Grand Army from Moscow furnishes a tragic but wonderfully vivid illustration of the strength of Russia's two invincible generals, January and February, who, if the scene of the present war should be transferred into Russia during the winter, would again be found fighting on the side of the Czar. We may note, in passing, that the French Revolution was precipitated by a severe winter, and that the "Boxer" outbreak in China, in 1900, was brought on by a scarcity of rain in the preceding autumn, leading to famine and destitution, and driving the people to robbery and pillage.

History is full of examples of individual engagements in which weather played an important, if not actually decisive part. Heavy rains, making the roads muddy and the movements of troops and of guns difficult, had a marked effect upon the plans of the commanding officers in the battle of Waterloo (1815), the battle itself being postponed for this reason. In our own civil war the list of weather controls is a long one. Of one of General Grant's campaigns in Virginia it is reported that the country was densely wooded and the ground swampy—the troops waded in mud above their ankles, horses sank to their bellies and wagons threatened to disappear altogether. The men began to feel that if any one in after years should ask them if they had been through Virginia, they could say, "Yes, in a number of places." Dense fog favored the northern forces in the battle of the Wilderness. Deep mud and impassable roads were, at least in part, responsible for General McClellan's delays, which caused so much anxiety and indignation in Washington. During the fighting around Tientsin in 1900 the situation of the allied troops was very critical, when a torrential rainfall compelled the Chinese to retire. Cold and snows have time and time again been potent factors in warfare. In the last Russo-Turkish war thousands of men died of the cold, and the sufferings of the troops at Plevna were terrible. The siege of Sebastopol furnishes another illustration of the sufferings which a severe winter inevitably produces. In the Russo-Japanese war fighting continued in the severe cold of the Manchurian winter. Frozen rivers or lakes may make it very easy for

an army to proceed on its plan of advance, and, on the other hand, the ice may help a pursuing army to follow its retreating enemy without the delay needed for building bridges. In 1780, troops were led on the ice from New Jersey to Staten Island, to attack the British, and provisions were sent across on sleighs. In 1809, the Russians were led to Sweden across the frozen Gulf of Bothnia. Sudden thaws after severe cold are often serious handicaps in a campaign. Roads and fields are suddenly turned from hard ground into deep mud or swamp, and the movement of troops, and especially of guns and supplies, may be stopped. Heat has caused as great suffering as has the cold, but less often, in our latitudes. The sufferings of the French army under General Kléber in Egypt in 1798 are well known to students of history. Officers threw themselves on the sand and gave way to despair.

If we look over the foregoing, and many other cases of weather controls in war, it is easy to see that these examples may be grouped in two classes. In one of these, the particular weather condition or phenomenon was so to speak accidental; it was sudden; unexpected at that special time; and therefore hardly to be guarded against. Cases of this sort are the sudden storms which have so often been decisive factors in military undertakings. In the second class the weather conditions were perfectly normal and natural for the particular region and season in which they occurred, but the army was not prepared for them because of the ignorance, or lack of foresight, or over-confidence, or haste, on the part of the commanding officers. Thus, the terrible disaster which befell the French army in Russia was largely due to Napoleon's own recklessness in rushing unprepared troops into the teeth of a northern winter. Cold and snow contributed towards making a disaster complete which would probably have been a serious one under any meteorological conditions. Again, during the British expedition into Tibet, a few years ago, great difficulty was experienced at the higher altitudes owing to the hardening of the oil in the guns, on account of the cold, and the low boiling point at those great altitudes made it difficult to cook food properly in the absence of special cooking utensils adapted for use at low pressures. These handicaps could have been provided against if proper care had been taken beforehand.

It is clear that weather, although not always, or ultimately, is a factor which must be reckoned with in warfare. It is one of a large number of factors, among which topography, soil, hydrography, vegetation, and so on, must also be included. To know, in advance, the general climate of the war zone; to be prepared for the special weather conditions which are reasonably to be expected at this or that season; to have as accurate a knowledge as possible of the probability of occurrence of severe cold; of sudden thaws; of heavy rains; of great heat; of high winds; of deep snows—this is a very essential element in plan-

ning a campaign or in organizing a single engagement. This is to make our knowledge of climate and of weather of immediate practical use, however much we may deplore the occasion which necessitates such use. Heavy rains make roads muddy and often impassable; delay the movements of troops, and of supplies; necessitate the abandonment of heavy guns and of ammunition; flood trenches and camps; cause discomfort and suffering, and bring on illness. Deep snows have many similar effects, but in addition are often accompanied by severe cold. Unless proper clothing, protection and fires can be provided, and often in spite of such precautions, severe cold almost inevitably increases the sufferings of the men, especially of the sick and wounded, causing an increase in the sick and mortality rates; disabling men through frostbites; making them unfit to march or to use their hands; freezing up water supplies, etc. Hot spells necessitate shorter marches, and may disable hundreds of men through sunstroke or heat prostration. Droughts make it difficult to secure water and food; cause dust which hampers the movements of troops, and may make their presence known to the enemy, and interferes with the accuracy of cannon and rifle firing. It does make a difference whether an army marches on dry, hard roads, or through deep and slippery mud; whether it suffers from frozen feet or is warm and comfortable; whether snow is falling or the sky is clear and the sun is shining; whether the wounded on the battlefield are soaked with rain, and beaten by hail, and covered with ice, or can be cared for under favorable conditions. As Sir John French put it, a few years ago: "The darker the night, the more inclement the weather, the more disagreeable the surroundings, the more valuable the training will be, and our young soldiers will gain some glimmering of what they must expect to meet in war."

Picked troops; discipline; a well-organized system of transport; proper clothing—in short, all that goes to make up the most efficient military organization, is of vastly more importance than the weather. But we fail to read history aright if we do not recognize that the weather element is by no means the least important of the many external factors which have affected military campaigns.

The present war gives us an immediate opportunity to study the influence of weather upon military operations. Although the war has lasted but three months, there are already many cases which may be cited in illustration.

During the first six weeks of the war the despatches made practically no mention whatever of the weather. Only incidentally was reference made to the oppressive heat. We may, therefore, conclude that there was nothing in the meteorological conditions in August and early September which had any noticeable effect upon the campaign. The mild and pleasant weather of the European late summer apparently ran its ac-

customed peaceful course. Suddenly, beginning with mid-September, we come upon constant reference to the difficulties caused by heavy rains. Autumnal rains, usually especially marked in October, are characteristic of the northern coasts of Europe. They come in connection with storms that drift in from the Atlantic Ocean, and pass eastward, across the Channel and the North Sea. It was to be expected that there would be many difficulties on account of the wet weather during the latter part of September and in October. The despatches from the front clearly show that the expected happened. Heavy rains during the long battle of the Aisne caused the rivers to swell; filled the trenches, and often drove the troops out to fight with their bayonets, thus changing the plan of operations. The difficulty, even the impossibility in some cases, of moving the heavy guns through the deep mud, was a serious handicap to both armies. During the general retreat of the Germans from their advanced position in France many guns and much ammunition had to be abandoned. On September 19 a despatch to a London paper said that the heavy rains had flooded such large areas that it was unlikely that the Germans could move their heavy siege guns towards Antwerp, but that these "would probably end in destruction in the mud." Subsequent events, however, proved this prediction a mistaken one. Nevertheless, the bad weather for a time threatened disaster to the Germans in that it delayed the arrival of reinforcements, and of provisions, and helped to demoralize the tired troops. The Allies, also, were prevented from advancing rapidly for similar reasons, and an extra time allowance was necessary in order that the various divisions could reach the ground assigned to them. The flooded rivers made the work of the "heroic engineers a veritable task of Hercules."

During the later fighting along the Franco-Belgian line, and near the Channel coast, the heavy rains continued to cause incessant trouble. "Torrential rains," producing "seas of mud"; "quagmires"; "morasses"; "bogs"—these are the expressions used to describe the condition of the region. Both sides were severely handicapped by the difficulty of moving the heavy artillery and motor trucks, but the Germans seem, on the whole, to have suffered most, with their heavy guns and motor trains. When the roads became impassable, the guns and trucks were driven through the fields, and in many cases became hopelessly stalled. The misty, rainy weather, making observation at a distance almost impossible, led to less artillery action. Autumnal fogs several times afforded a protecting cover which made a sudden assault on the enemy's trenches possible. At times, when the weather was especially stormy, the fighting ceased entirely. We read that "General Rain" helped the Allies. The discomfort of all the troops was very greatly increased because of the growing cold as autumn came on, the cool, damp nights and early mornings proving espe-

cially trying. It is interesting to note that the Belgian troops who were interned in Holland after the fall of Antwerp accidentally crossed the Dutch frontier in the dark, rainy night of their march.

These autumn rains were not limited to the Franco-Belgian war zone. In the eastern campaign, in late September, we read that the roads were quagmires and that the German troops who were advancing against the Russians were greatly hampered by the difficulty of moving the heavy guns and armored motor cars. In early October the rain and mud in this district interfered with the movements of both armies, but the Russians had the advantage because their field guns and wagons are especially designed for going through mud and soft ground, as a result of their development in districts where there are few good roads. The German artillery and automobile trucks, on the other hand, built low for service on hard ground, were moved with great difficulty or not at all. Hence the rain and the mud fought on the side of the Russians. The troops of the Czar got more of their artillery into action, and used it sooner. The Germans even found it impossible to protect themselves in the customary roofed-over trenches, because the soil was so saturated with water.

Late in October, in the campaign around Warsaw, heavy rains seem largely to have defeated the German plan of operations. The deficiency in railroads was to be made good by means of long trains of fast motor cars, but the mud was so deep that whole roads are reported to have been blocked with abandoned German transports and guns. In the advance towards Warsaw, the German artillery was so much delayed by the mud that it could not be brought up to strengthen the advance guard. The Russians captured many guns which had been abandoned in the mud. The big Krupp siege guns, which proved so effective in the west, where the roads are good, were a serious handicap in the east. Up to the end of October no important fortress had been taken by bombardment by the Germans in the east. In the west, fortress after fortress fell under the heavy gun fire. In such a region, of lowlands and swamps, winter cold, by freezing the ground, will make campaigning easier.

It is clear from these few illustrations that modern warfare has in no way become independent of the handicaps imposed by rain. Motors instead of horses are used to pull artillery and supply trains, but the guns have become heavier, and deep sticky mud is just as serious an obstacle as it ever was.

The grim specter of winter began to rise above the horizon as far back as the middle of September, and almost every day since then has brought some new evidence of the nearer approach of the cold, and the snow, and the suffering which are sure to come with the shortening days and the lowering sun. Modern wars are intense. They do not come to a dead stop in winter. The armies do not go into winter quarters as

they did in the old days. The soldiers in the present war will suffer from the cold; the icy roads will make it difficult for horses to keep their footing; the snow will block roads and delay marching and transportation, just as has happened in the wars of the past under similar weather conditions. Modern methods of transportation are so well-organized that winter storms and cold do not interfere as much as was formerly the case, yet the movements of the heavy guns, the automobiles and the motor trucks of the present-day army are likely to be blocked by deep snows at least as effectively as was once the case when horses were exclusively used.

From Galicia, with its high ground and its exposure northwards, towards the great Russian lowland, came, in mid-September, the first mention of the suffering of troops from the cold. Early in October we read that the soldiers there were marching and camping in the snow. The Russians, well protected by their heavy overcoats, suffered little discomfort, but the Austrians whose winter clothing had been captured by the Russians in Lemberg were less fortunate. Whatever may have been the other reasons for the Russian advance into Austrian Poland, it is clear that this southern route into Austrian and perhaps later into German territory would naturally give the longest open season for the prosecution of the campaign. In the northeast, the Germans seem to have been surprised by the setting in of cold weather in the first half of October, and, not having heavy clothing, they are reported to have suffered severely. The Russians, on the other hand, were well protected, having fur caps covering both their heads and necks and being otherwise well equipped with requisites for a fall and winter campaign. It is not unlikely that the Germans, even if they were distinctly victorious in this zone, would think of penetrating far into Russia, to face, as did Napoleon, the might of Generals January and February. Heavy rains and sleet made speedy movements of troops difficult in early October. Toward the latter part of October snow was interfering with the offensive of the Russian army in Poland, because delaying the movement of their transport. The German and Austrian troops, therefore, retreated less rapidly, and made a more determined resistance. They were, however, themselves greatly hampered by a breakdown of their own supply trains. It is probable that the German activity against Russia in the east has been at least in part due to the desire to gain a distinct advantage before the setting in of the rigorous Russian winter. The capture of Warsaw before winter would have greatly strengthened the German line in East Prussia, would have endangered the Russian frontier in Galicia and would have had a distinct moral effect on the Poles. Further, if a large body of German troops could then be transferred to France, a new campaign against Paris might perhaps be attempted during the milder French winter. The Russians are more ac-

customed to severe cold than are the men from the west and south of Europe, and will probably prosecute the war with little diminution of energy. The Germans have evidently been preparing for the winter fighting in Poland, for the troops which went to the front early in October were equipped with fur gloves and sheepskin coats.

In the French and Belgian war zone the September rains are noted as having brought lower temperatures, "with a distinct feeling of autumn in the air, especially in the early mornings." This warning chill, with cold winds, seemed to arouse all the commanders to a sudden realization of the unpreparedness of their troops for a winter campaign. The terrors of the winter suddenly loomed up on the horizon of warring Europe. Living outdoors and in trenches is bad enough when the weather is favorable, but the sufferings of the men, especially of the sick and wounded, when the weather is cold are immeasurably greater. The lowered vitality of the wounded leads to many deaths from the cold, even if none of the men are actually frozen to death, as has so often happened in previous winter campaigns in Europe. On all sides we hear of preparations for winter. The German Crown Prince, some weeks ago, telegraphed to the Emperor for winter socks and underclothing for his men. Germany has ordered sheepskin clothing from Rotterdam; fur coats to the number of 150,000, presumably for the use of German officers, have already been delivered, and 2,000,000 sheep and lambskins have been bought for the use of the men. People ordinarily employed in glove-making are now engaged in providing the troops with clothing made from the skins usually taken for gloves. For the German cavalry, special leather leg protectors are being made. The French minister of war some time ago sent a circular to all the prefects, requesting them to obtain as rapidly as possible supplies of woolen underclothes, socks, gloves and blankets for the use of the French soldiers during the winter. England has made special provision for her Indian troops in the way of mufflers and warm underwear; has commandeered large quantities of woolen goods, and is importing from this country at the present time immense numbers of rubber boots and cardigan jackets. The difficulty of digging trenches, and of living in them, is greatly increased when the weather is wet and cold. Under date of October 16, we read that the allied troops are protecting themselves in the trenches with blankets and waterproof sheets, and are guarding against the cold by wearing "sheets of parchment" under their uniforms. Dug-outs are being cut under the sides of the trenches for the men to sleep and take shelter in. These refuges are raised somewhat above the bottom of the trenches, so that they are dry in wet weather. Some of the trenches are now provided with cover overhead, for protection against the weather as well as against the shrapnel fire. In the last week of October snow fell in the Vosges, in considerable amounts, and also at sev-

eral points along the French frontier. The nights were reported as becoming steadily colder. The French colonial troops, especially those from Africa, were stated to be "benumbed by the cold."

There are many respects in which the weather is of more importance in warfare to-day than it ever was in the past. The use of searchlights and aeroplanes in directing ordnance fire, and the greatly increased mortality caused by modern artillery, make the protection of troops, in trenches or otherwise, of essential importance. A low cloud, a fog, a snowstorm, a heavy rain, may give just the protection needed, and yet not interfere with the free movement of the troops. In this very war, the surrender of Namur was hastened by a heavy fog, which enabled the Germans to plant their siege guns in a good position and without danger to themselves.

It is hardly necessary to point out that in the matter of aeroplanes and airships modern warfare is far more dependent upon weather conditions than it ever was. Since the great war began we have had many illustrations of this fact. It seems to be a fairly well established point that in order to have his reconnaissance of real value the observer in an aeroplane must, unless the weather is unusually clear, come down low enough to be in danger of gun and rifle fire. Fogs and low clouds obscure the surface from an aerial observer. Wind may wholly interfere with his work at a time when his report is most needed. The increasing numbers of London fogs with the coming on of autumn led to great anxiety in London on account of possible Zeppelin attacks. Tests were made at the end of September to ascertain whether searchlights can detect a Zeppelin even through a fog. A warning has been issued by aviation experts to the effect that an attack on London is most likely on a clear calm night. Foggy and misty weather hampered aerial reconnaissance in northeastern France during the October storms. In a despatch dated October 24, from Paris, we read that the aviators who were protecting the region over Paris suffered severely in "terrible hail and snowstorms." The German aviators, it is noted, set out according to schedule, in spite of unfavorable weather. It is not difficult to realize how serious the lack of a daily European weather map must now be to the whole aerial campaign. Germany, in particular, if she plans a Zeppelin raid on England, will find the lack of observations from the British Isles most serious. Possibly some of the secret wireless stations which are reported to have been discovered in Great Britain were used for sending daily weather reports to Germany. So far as the naval side of the war is concerned, there has thus far been little or nothing to note on the meteorological aspects. With the approach of winter, and the increase of stormy weather over the northern seas, we may not unreasonably look for losses due to gales, and thick weather, and fogs, and to suffering from the cold. Rough water and fog make the ap-

proach of a submarine difficult or impossible to see, and therefore help the attacking vessel. We note that the weather was "bitterly cold" at the time when the British cruiser *Hawke* was torpedoed, so that the chances of saving the men who were struggling in the water were greatly lessened. Special precautions should be taken to guard against collision, shipwreck and submarine attack, as the winter comes on. The German fleet is doubtless waiting for a winter gale to scatter the British ships. At the end of October a severe storm was raging in the North Sea—a sure sign of the approach of winter—and was making life on board of the smaller vessels, the torpedo boats and submarines, most uncomfortable. Archangel, which evidently served as a very important port for the Allies during the summer, is now frozen, and will remain so until next summer.

Thus, throughout the area of the Great War, the weather from day to day is playing its part in the campaign. Modern military tactics; modern armament; modern methods of all kinds, have not in any way eliminated the weather element as a factor of the greatest importance. The story of the present war does not, thus far, read so very differently from that of the stories of previous wars in the same countries. In 1586, the Spanish, as related by Motley, encountered such terrible rains on the Meuse that they retreated. A previous fall of Namur, in 1692, was largely due to heavy rains which prevented the English from crossing the river and meeting the besieging French army. The English in Flanders in 1708–09 endured great hardships on account of deep snows, which blocked the roads. The cold was intense and the troops, who were short of firewood, suffered severely. The Duke of Marlborough wrote (1708): "Till this frost yields we can neither break ground for our batteries nor open our trenches." The French, in Poland, in 1806–07, found mud 3 feet deep; drenching rains; driving sleet; melting snow and icy streams. In the Franco-Prussian War of 1870–71, over the same historic ground in France, we read of torrential rains; floods; icy roads; muddy fields, and of sufferings on account of cold.

So the story goes on, from age to age, from one war to the next. War and the weather: they are related to-day, as they were in the past, physically, physiologically, psychologically, and as they will be until wars shall cease.

DROPPING THE PILOT:
Tenniel's cartoon, printed in *Punch* in 1890.

THE PROGRESS OF SCIENCE

WAR AND PUBLIC OPINION

IT is difficult to write, speak or think about anything except the war now devastating Europe and the earth. Although social and economic questions can not be treated with the same objectivity as the natural and exact sciences, THE POPULAR SCIENCE MONTHLY has always included them in its scope, the immediate ground of its establishment in 1872 having indeed been the need of a journal in which to publish Herbert Spencer's "Principles of Sociology." That work takes an attitude strongly opposed to militarism and discusses the difficulties of obtaining scientific points of view in sociology owing to national interests and prejudices.

The events of forty-two years have enforced the arguments of Herbert Spencer and to-day their truth is convincingly exhibited, at least in the sight of most of us. But it must be admitted that the two arguments are not on the same scientific plane. When it is claimed that armaments and war are not only inevitable, but may be desirable for a nation and for the world, there is no scientific disproof, only conviction against prejudice or prejudice against conviction, as the case may be.

The extent to which belief may be determined by emotion is demonstrated by the fact that the people of each of the nations now involved hold that they are engaged in a war of defense against the selfish and wanton aggression of their opponents. We have been requested to print a manifesto, addressed "To the Civilized World" by ninety-three leading representatives of German science and art, including Professors von Baer, von Behring, Ehrlich, Fischer, Haeckel, Klein, Nernst, Ostwald, Röntgen, Waldeyer and Wundt. They say:

It is not true that Germany is guilty of having caused this war. Neither the people, the government, nor the "Kaiser" wanted war. Germany did her utmost to prevent it; for this assertion the world has documental proof. . . . *It is not true* that we trespassed in neutral Belgium. . . . *It is not true* that the life and property of a single Belgian citizen was injured by our soldiers without the bitterest self-defence having made it necessary. . . . *It is not true* that our troops treated Louvain brutally. . . . We can not wrest the poisonous weapon—the lie—out of the hands of our enemies. All we can do is to proclaim to all the world, that our enemies are giving false witness against us. You, who know us, who with us have protected the most holy possessions of man, we call to you: Have faith in us! Believe, that we shall carry on this war to the end as a civilized nation, to whom the legacy of a Goethe, a Beethoven and a Kant, is just as sacred as its own hearths and homes. For this we pledge you our names and our honor.

A reply alleging the exact contrary has been signed by one hundred and thirty leading British professors, authors, artists and men of science, including Lord Rayleigh, Sir William Ramsey, Sir William Crookes, Sir William Osler, Sir Ronald Ross, Sir William Turner, Professor Sherrington and Professor Schuster. They say:

We grieve profoundly that under the baleful influence of a military system and its lawless dreams of conquest she whom we once honored now stands revealed as the common enemy of Europe and of all peoples which respect the laws of nations. We must carry on the war on which we have entered. For us, as for Belgium, it is a war of defense waged for liberty and peace.

The workings of the psychology of the crowd may be illustrated by a minor incident. German scientific men have renounced the honorary degrees conferred on them by British universities, and German scientific men who had attended as invited guests the Australian

meeting of the British Association are being held as prisoners of war in England. But at the meeting of the association after the outbreak of war these same scientific men received honorary degrees from a British university with special applause.

When public opinion in regard to war is so subject to emotional control, the way of wisdom is to avoid war and the conditions leading to war, even to the extent of holding that there never is a good war or a bad peace. The only gleam of hope in the present situation is that public sentiment in this country is against war and against the nations which, rightly or wrongly, are supposed to be the aggressors, and that each nation is anxious to disclaim responsibility for the existing chaos. In its inception the war was an affair of militarists and diplomatists, and Germany was unfortunate in combining these two classes in the same clique. All would have been different if there had been a Bismarck to whom the military machine was subordinated; there might have been war between Russia and Germany, but there would have been no European war. Conditions were better in Great Britain, and diplomacy tried to prevent war, but when war came then diplomacy had involved the people in its tricks.

Suddenly out of its stale and drowsy lair, the lair of slaves,
Like lightning it leap't forth half startled at itself,
Its feet upon the ashes and the rags, its hands tight to the throats of kings.

But none of us can see clearly in the storm and in the darkness. It is our helplessness, the horror of it all, the pity of it all, that overwhelm us. The only safe conclusion is that the work of the world for science and for civilization must be maintained. We may well honor the Paris Academy of Sciences for continuing its meetings when the enemy were at the gates of Paris and the government had fled; the scientific men and scholars of Strassburg for opening the sessions of the university at the usual time. And most of all it is our business to carry forward the flickering torch. The fact that the greatest nations of Europe will be prevented, not only this year but for some years to come, from doing their share of scientific work, makes it all the more necessary that the scientific men, the scientific institutions and the scientific journals of this country should maintain and increase their efforts.

CRYSTALS AND X-RAYS

As part of the celebration of the one hundred and fiftieth anniversary of the founding of Brown University a series of meetings and courses of lectures have been arranged. One of the most interesting of these was a series of four lectures by Professor William Henry Bragg, F.R.S., of the University of Leeds, discussing the important work that has recently been done on the phenomena resulting from the passage of X-rays through crystals.

Two years ago an experiment of great beauty and extreme scientific importance was successfully carried out in the physical laboratories at Munich by Friedrich and Knipping, acting on a brilliant suggestion made by Laue, a member of the staff of the university at Zurich. To put it very briefly the experiment consisted in the exposition of the interference effects accompanying the passage of X-rays through crystals, and it proved that X-rays consist of extremely short waves in the ether. It is now clear that X-rays are exactly the same thing as light rays, except that the wave length is roughly ten thousand times smaller. The significance of this discovery can not be compressed into a single sentence because it points in several independent directions.

In the first place, the result is of the greatest importance in connection with the general theories of radiation. The undulatory theory of light has been extraordinarily successful in correlating experimental facts. Towards the end of the last century it seemed as if it had conquered all the great problems of physical optics. More recently it has

shown signs of inefficiency. For example, it seems unable to account for the so-called photo-electric phenomena. Incapacity has been still more obvious in connection with the properties of X-rays. At one time it seemed, at least to some, easier to deny the identity of light- and X-rays than to force the orthodox theory to yield an explanation of X-ray effects. When therefore the identity is established by the new experiment, a very interesting position results. The orthodox theory is to be supplemented in some way not yet clear. It will then be, surely, far more effective than it ever has been before. From our new point of view our difficulties are more clearly defined, but, at the same time, we shall probably receive new help to their solution.

In the second place a method of analyzing X-rays has been evolved from the original experiment. The wave lengths of X-rays can now be measured exactly, and other characteristics of X-rays can be expressed in terms of these. Remarkable relations have already been found to exist, for instance, between the wave lengths of the X-rays emitted by various atoms under proper stimulus and the positions of those atoms in the table of Mendelejeff. Much light is thereby thrown upon the meaning of the table, and a limit is set to the number of its vacant places, that is to say of elements not yet discovered.

Again, the new experiments provide a means of investigating the structure of crystals. We are able to determine the arrangement of the atoms in a crystal and to measure the distance from atom to atom. The science of crystallography can be built on a firmer basis than before, for it can now take account of the internal structure of the crystals whereas it has hitherto relied on observations of the external form.

Finally, the motions of the atoms about their average positions are made manifest. Little experimental work has yet been done in this direction, but it does not seem unlikely that we shall presently measure with exactness the extent of the atomic movements which contribute to the heat content of a body.

Professor Bragg's lectures were devoted to an attempt to explain more fully the statements outlined above. In the first lecture the general question was considered. Laue's experiment was described and interpreted and its meaning discussed. The subject of the second was W. L. Bragg's restatement of Laue's theory, together with its important consequence, viz., the X-ray spectrometer and its powers. The third was devoted to the consideration of crystal structure in the light of the new discovery, and the fourth to X-ray spectra, the relation of X-ray properties to wave length, and the thermal movement of the atoms in the crystal.

NATURAL SCENERY FOR MUSEUM EXHIBITS

In connection with the rearranging of the scenic effect of one of the Roosevelt animal groups in the National Museum, actual African plants and grasses are to be filled with plaster and preserved in their natural state to give the animal specimens local color. In the art of modern taxidermy the old system of simply "stuffing" the skins of animals has been done away with, and a standard method of accurate life-size modeling established. Over a carefully made plaster cast of this model the skin is stretched, glued and sewed, so that it is difficult to see how it was accomplished; for the moment it is easy to believe that the animal itself has been preserved intact in some marvelous manner.

For many years past the National Museum has been employing natural scenery—real grass, foliage and soil—in its biologic and ethnographic groups, much as in theatrical effects, to create a natural atmosphere. Now-a-days, museums do not simply mount individual animals on a platform and place them in a case. They are mounted in natural attitudes, and ground work, suitable to both the environment and the posture of the figures, is prepared.

FRANKLIN MEDAL.

Founded by the Franklin Institute as the result of a gift from Samuel Insull, Esq., of Chicago, to be awarded for eminence in science or the applications of science to industry.

The animals are often arranged in family or social groups that the student or spectator can gleam something more than an impression of how an isolated specimen looks. Physical geography, geology, botany and other studies now enter the field of taxidermy.

In preparing a new setting for the African buffalo group, built in the National Museum about a year ago, the three animals are to be left in their original positions, which indicate alarm, just as they were first discovered by the hunters, but in addition they are to be represented as standing on the edge of an African papyrus swamp. The ground-work of the group will present the effect of the marshland where the buffalo live, the grasses and plants being added, that a complete picture of the African swamp may be effected.

Since nearly all grasses and foliage are subject to decay and shrinkage, with constant loss of original form and color, they, like the skins of the animals, are especially prepared. Few grasses, as a rule, can be dyed or preserved in anything like their natural form, but, fortunately, to this end the papyrus lends itself very well. The plants having thick stems are opened, and the pithy inner removed; they are then bent or curved and secured in the position desired, wired and filled with plaster. When the plaster is set, the plants are painted to represent their colors in life, and grouped together with other grasses to form a setting for the animals.

When the African buffalo group was first assembled, as no African material was yet at hand, it was decided to use temporarily cosmopolitan foliage which was to be found here as well as in Africa. Although the artistic effect proved very satisfactory, the museum officials determined to have this group as technically correct in every detail as the lion, the hartebeest, and the rhinoceros groups already on exhibition, and finally arrangements were made whereby the native African material was obtained. Several cases of papyrus plants and arundo grass were secured from the natural habitat of these buffalo, and the animals, set in their true environment, will soon be placed on exhibition again.

SCIENTIFIC ITEMS

WE record with regret the death of Professor August Weismann, the distinguished German zoologist; of Dr. Henry Gannett, geographer of the U. S. Geological Survey; of Bernard Richardson Green, civil engineer and superintendent of the Congressional Library, and of Mr. G. R. Mines, professor of physiology in McGill University, who died while making experiments in his laboratory on the action of the heart, apparently as the result of some failure in the apparatus.

Professors Roentgen, Lenard and Behring have each recently been reported to have repudiated the gold medals conferred on them by scientific associations in Great Britain, and have donated them to the Red Cross or other relief work, and now it is said that the Hanbury medal has likewise been donated for relief work by its recipient, Dr. E. Schmidt, professor of pharmacology at Marburg.

THE past and present members of the scientific staff of the Rockefeller Institute for Medical Research gave a dinner at Delmonico's to Dr. Simon Flexner on October 16, in celebration of the tenth anniversary of the opening of the laboratories of the institute under his direction.—At the celebration of the twenty-fifth anniversary of the Johns Hopkins Hospital a portrait of Sir William Osler, by Mr. Sargeant, was presented.

THE National Academy of Sciences will hold its autumn meeting at the University of Chicago on December 7, 8 and 9.—The American Association for the Advancement of Science and the national scientific societies affiliated with it will hold their convocation week meetings at the University of Pennsylvania, Philadelphia, during the week beginning on January 3.

INDEX

NAMES OF CONTRIBUTORS ARE PRINTED IN SMALL CAPITALS

American, Genius, The Geographical Distribution of, SCOTT NEARING, 189; Whaling Industry, Graphics of the, J. ARTHUR HARRIS, 83
Americans, Foreign-born, The Political Mind of, ADAM LIPSKY, 397
ANDREWS, LAUNCELOT W., A New Phase of an Old Conflict, 541
Apiculture in the Time of Virgil, GEORGIA WILLIS READ, 167
Arabian and Medieval Surgery, JOHN FOOTE, 467

Bad Habit of having Law Makers and Lawyers, JOHN COTTON DANA, 87
BALDWIN, BIRD T., The Normal Child, its Physical Growth and Mental Development, 559
Botanical Station, The Chinchona, DUNCAN S. JOHNSON, 521
British Association for the Advancement of Science, Address of the President, 412

CANNON, W. A., Tree Distribution in Central California, 417
CARLTON, FRANK T., Ephemeral Labor Movements, 1866–1889, 487
CARNEGIE, ANDREW, A League of Peace, 296
CATTELL, J. MCKEEN, Science and International Good Will, 304
Cellular Basis of Heredity and Development, EDWIN GRANT CONKLIN, 105, 232
Child, The Normal, its Physical Growth and Mental Development, BIRD T. BALDWIN, 559
Chinchona Botanical Station, DUNCAN S. JOHNSON, 521
Cincinnati New General Hospital, 101
Civilization as a Selective Agency, ROLAND HUGINS, 476
College, The Small, and Its Faculty, ONE OF THE PRESIDENTS, 184
Common Factors in Mental Health and Illness, F. LYMAN WELLS, 569
Conflict, Old, A New Phase of an, LAUNCELOT W. ANDREWS, 541
Coniferous Forests of Eastern North America, ROLAND M. HARPER, 338
CONKLIN, EDWIN GRANT, Facts and Factors of Development, 21; The Cellular Basis of Heredity and Development, 105, 232; Phenomena of Inheritance, 313, 425
Conservation and Exchange, Union and Cooperation, The Evolution of Service by, WILLIAM PATTEN, 404
Coral Reefs of Torres Straits, An Expedition to the, ALFRED GOLDSBOROUGH MAYER, 209
Crystals and X-rays, 131
Cultivation of Waste Land, The, A. D. HALL, 377

DANA, JOHN COTTON, The Bad Habit of having Law Makers and Lawyers, 87
Darwin, Major Leonard, Address before the Eugenics Education Society, 205
Darwinism, Organic Evolution and the Churches, 103
Decreasing Population of France, JAMES W. GARNER, 247
Democracy, Municipal, Home Rule, the Hope of, OSWALD RYAN, 392
Desert Basin, A Comprehensive Study of a, 413
Determining Educational Values, M. V. O'SHEA, 284
Development, Facts and Factors of, EDWIN GRANT CONKLIN, 21; and Heredity, the Cellular Basis of, EDWIN GRANT CONKLIN, 105, 232
Distribution of Scientific Men among the different nations, 516
Ductless Glands, Internal Secretions and Hormonic Equilibrium, FIELDING H. GARRISON, 531

East Wind, The Paradox of the, ALEXANDER MCADIE, 292
Education, Elementary and Secondary, Waste in, FRANKLIN W. JOHNSON, 40; Work of General Board, 101; The Science of, JOHN PERRY, 504
Educational Values, Determining, M. V. O'SHEA, 284
Elementary and Secondary Education, Waste in, FRANKLIN W. JOHNSON, 40
EMMERICK, CHARLES F., The Struggle for Equality in the United States, 56
Ephemeral Labor Movements, 1866–1889, FRANK T. CARLTON, 487
Equality, The Struggle for, in the United States, CHARLES F. EMERICK, 56
Equilibrium, Hormonic, Internal Secretions and Ductless Glands, FIELDING H. GARRISON, 531
Ethnic Factors in International Relations, MAURICE PARMELEE, 146

Eugenics Education Society, Major Leonard Darwin's Address, 205
Evolution, Organic. Darwinism and the Churches, 103; of Mind, The Rôle of Sex in, S. J. HOLMES, 200; of Service by Union and Cooperation, Conservation and Exchange, WILLIAM PATTEN, 404
Expedition to the Coral Reefs of Torres Straits, ALFRED GOLDSBOROUGH MAYER, 209

Factors, Common, in Mental Health and Illness, F. LYMAN WELLS, 569
Facts and Factors of Development, EDWIN GRANT CONKLIN, 21
Foes, How We defend Ourselves from Our, FRASER HARRIS, 93
Food Supplies, Available, J. F. LYMAN, 180
FOOTE, JOHN, Arabian and Medieval Surgery, 467
Foreign-born Americans, The Political Mind of, ABRAM LIPSKY, 397
Forests, Coniferous, of Eastern North America, ROLAND M. HARPER, 338
France, The Decreasing Population of, JAMES W. GARNER, 247
FRENCH, HAROLD, Genesis and Revelations of the Yosemite Valley, 69

GARNER, JAMES W., The Decreasing Population of France, 247
GARRISON, FIELDING H., Ductless Glands, Internal Secretions and Hormonic Equilibrium, 531
Genesis and Revelations of the Yosemite Valley, HAROLD FRENCH, 69
Genius, American, The Geographical Distribution of, SCOTT NEARING, 189
German Militarism, its Influence upon the Industries, HUGO SCHWEITZER, 582
Glands, Ductless, Internal Secretions and Hormonic Equilibrium, FIELDING H. GARRISON, 531
Graphics of the American Whaling Industry, J. ARTHUR HARRIS, 83
Growth, Physical, and Mental Development of the Normal Child, BIRD T. BALDWIN, 559

HALL, A. D., The Cultivation of Waste Land, 377
HARPER, ROLAND M., The Coniferous Forests of Eastern North America, 338
HARRIS, FRASER, How We defend Ourselves from Our Foes, 93
HARRIS, J. ARTHUR, Graphics of the American Whaling Industry, 83
Health, National, The Value of Research in the Development of, BENJAMIN MOORE, 362; Mental, and Illness, Common Factors in, F. LYMAN WELLS, 569
Heredity and Development, EDWIN GRANT CONKLIN, 21, 105, 232, 313, 425
HOLMES, S. J., The Rôle of Sex in the Evolution of Mind, 200
Home Rule, The Hope of Municipal Democracy, OSWALD RYAN, 392
Hope for the Russian Peasantry, LUCY ELIZABETH TEXTOR, 590
Hormonic Equilibrium, Ductless Glands and Internal Secretions, FIELDING H. GARRISON, 531
HOROWITZ, B., The Ultra-Scientific School, 463
HOWARD, ROSSITER, Pleasure in Pictures, 155
HUGINS, ROLAND, Civilization as a Selective Agency, 476

Illness, Mental, and Health, Common Factors in, F. LYMAN WELLS, 569
Increase, Natural, of Races of European Nations, 309
Industries, German Militarism, its Influence upon the, HUGO SCHWEITZER, 582
Inheritance, Phenomena of, EDWIN GRANT CONKLIN, 21, 105, 232, 313, 425
International Relations, Ethnic Factors in, MAURICE PARMELEE, 146
Internal Secretions, Hormonic Equilibrium and Ductless Glands, FIELDING H. GARRISON, 531

JAMES, WILLIAM, The Moral Equivalent of War, 298
JOHNSON, DUNCAN S., The Chinchona Botanical Station, 521
JOHNSON, FRANKLIN W., Waste in Elementary and Secondary Education, 40
JONES, EDWARD D., The Rise of a New Profession, 260
JORDAN, DAVID STARR, War and Manhood, 301

Labor Movements, Ephemeral, 1866–1889, FRANK T. CARLTON, 487
Lawyers, and Law Makers, The Bad Habit of having, JOHN COTTON DANA, 87
LIPSKY, ABRAM, The Political Mind of Foreign-born Americans, 397
LYMAN, J. F., Available Food Supplies, 180

MCADIE, ALEXANDER, The Paradox of the East Wind, 292
MACDOUGALL, ROBERT, The Picture and the Text, 270
Man and the Microbe, C.-E. A. WINSLOW, 5
Manhood, and War, DAVID STARR JORDAN, 301

Marine Biological Laboratory, Woods Hole, 203
Mathematical Activities, Recent, G. A. MILLER, 457
MAYER, ALFRED GOLDSBOROUGH, An Expedition to the Coral Reefs of Torres Straits, 209
Medieval and Arabian, Surgery, JOHN FOOTE, 467
Mental, Development, The Normal Child, its Physical Growth and, BIRD T. BALDWIN, 559; Health and Illness, Common Factors in, F. LYMAN WELLS, 569
Microbe and Man, C.-E. A. WINSLOW, 5
Militarism, German, its Influence upon the Industries, HUGO SCHWEITZER, 582
MILLER, G. A., Recent Mathematical Activities, 457
Mind, Evolution of, The Rôle of Sex in, S. J. HOLMES, 200
MOORE, BENJAMIN, The Value of Research in the Development of National Health, 362
Moral Equivalent of War, WILLIAM JAMES, 298
Municipal Democracy, Home Rule, The Hope of, OSWALD RYAN, 392

National, Educational Association, St. Paul Meeting, 204; Health, The Value of Research in the Development of, BENJAMIN MOORE, 362
NEARING, SCOTT, The Geographical Distribution of American Genius, 189
New Phase of an Old Conflict, LANCELOT W. ANDREWS, 541
Nitrate Deposits, The Origin of, WILLIAM H. ROSS, 134
Normal Child, its Physical Growth and Mental Development, BIRD T. BALDWIN, 559

ONE OF THE PRESIDENTS, The Small College and its Faculty, 184
Opinion, Public and the War, 615
Origin of Nitrate Deposits, WILLIAM H. ROSS, 134
O'SHEA, M. V., Determining Educaltional Values, 284

Paradox of the East Wind, ALEXANDER MCADIE, 292
PARMELEE, MAURICE, Ethnic Factors in International Relations, 146
PATTEN, WILLIAM, The Evolution of Service by Union and Cooperation, Conservation and Exchange, 404
Peace, A League of, ANDREW CARNEGIE, 296
Peasantry, the Russian, Hope for, LUCY ELIZABETH TEXTOR, 590
PERRY, JOHN, The Science of Education, 504
Phenomena of Inheritance, EDWIN GRANT CONKLIN, 313, 425
Physical Growth and Mental Development of the Normal Child, BIRD T. BALDWIN, 559
Picture, and the Text, ROBERT MACDOUGALL, 270
Pictures, Pleasure in, ROSSITER HOWARD, 155
Political Mind of Foreign-born Americans, ABRAM LIPSKY, 397
Population, The Decreasing, of France, JAMES W. GARNER, 247
Progress of Science, 101, 203, 308, 412, 516, 615
Profession, New, The Rise of a, EDWARD D. JONES, 260
Public Opinion and the War, 615

Races of the European Nations and their Natural Increase, The, 309
READ, GEORGIA WILLIS. Apiculture in the Time of Virgil, 167
Recent Mathematical Activities, G. A. MILLER, 457
Reefs, Coral, of Torres Straits, An Expedition to the, ALFRED GOLDSBOROUGH MAYER, 209
Research, The Value of, in the Development of National Health, BENJAMIN MOORE, 362
Revelations, and Genesis, of the Yosemite Valley, HAROLD FRENCH, 69
Rise of a New Profession, EDWARD D. JONES, 260
Rôle of Sex in the Evolution of Mind, S. J. HOLMES, 200
ROSS, WILLIAM H., The Origin of Nitrate Deposits, 134
Rubber: Wild, Plantation and Synthetic, JOHN WADDELL, 443
Russian Peasantry, Hope for the, LUCY ELIZABETH TEXTOR, 590
RYAN, OSWALD, Home Rule, the Hope of Municipal Democracy, 392

SCHWEITZER, HUGO, German Militarism, its Influence upon the Industries, 582
Science, The Progress of, 101, 203, 308, 412, 516, 615; and International Good Will, J. MCKEEN CATTELL, 305; of Education, JOHN PERRY, 504; and the War, 516
Scientific, Items, 104, 208, 311, 415, 519, Men, The Distribution of, among the Different Nations, 516
Secondary Education, and Elementary, Waste in, FRANKLIN W. JOHNSON, 40
Secretions, Internal, Hormonic Equilibrium and Ductless Glands, FIELDING H. GARRISON, 531
Selective Agency, Civilization as a, ROLAND HUGINS, 476
Service, The Evolution of, by Union and Cooperation, Conservation and Exchange, WILLIAM PATTEN, 404

Sex, The Rôle of, in the Evolution of Mind, S. J. HOLMES, 200
Small College and Its Faculty, ONE OF THE PRESIDENTS, 184
Struggle for Equality in the United States, CHARLES F. EMERICK, 56
Surgery, Arabian and Medieval, JOHN FOOTE, 467
Synthetic Rubber, Wild and Plantation, JOHN WADDELL, 443

TEXTOR, LUCY ELIZABETH, Hope for the Russian Peasantry, 590
Torres Straits, An Expedition to the Coral Reefs of, ALFRED GOLDSBOROUGH MAYER, 209
Tree Distribution in Central California, W. A. CANNON, 417

Ultra Scientific School, B. HOROWITZ, 463
Union and Cooperation, Conservation and Exchange, The Evolution of Service by, WILLIAM PATTEN, 404
United States, The Struggle for Equality in the, CHARLES F. EMERICK, 56

Value of Research in the Development of National Health, BENJAMIN MOORE, 362
Values, Educational, Determining, M. V. O'SHEA, 284
Virgil, Apiculture in the Time of, GEORGIA WILLIS READ, 167

WADDELL, JOHN, Rubber: Wild, Plantation and Synthetic, 443
War, and Peace, ANDREW CARNEGIE, 296; The Moral Equivalent of, WILLIAM JAMES, 298; and Manhood, DAVID STARR JORDAN, 301; The Mad, 308; public opinion and the, 615
WARD, ROBERT DEC., The War and the Weather during the First Three Months of the War, 604
Waste, in Elementary and Secondary Education, FRANKLIN W. JOHNSON, 40; Land, The Cultivation of, A. D. HALL, 377
Weather, The War and the, during the First Three Months of the War, ROBERT DEC. WARD, 604
WELLS, F. LYMAN, Common Factors in Mental Health and Illness, 569
Whaling Industry, American, Graphics of the, J. ARTHUR HARRIS, 83
Wind, East, The Paradox of the, ALEXANDER MCADIE, 292
WINSLOW, C.-E. A., Man and the Microbe, 5

X-rays and crystals, 131
Yosemite Valley, Genesis and Revelations of the, HAROLD FRENCH, 69

Vol. LXXXV, No. 6 DECEMBER, 1914

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CONTENTS

The Cinchona Botanical Station. Professor DUNCAN S. JOHNSON . . 521
Ductless Glands, Internal Secretions and Hormonic Equilibrium. Dr. FIELDING H. GARRISON 531
A New Phase of an Old Conflict. LAUNCELOT W. ANDREWS . . 541
The Normal Child, its Physical Growth and Mental Development. Professor BIRD T. BALDWIN 559
Common Factors in Mental Health and Illness. Dr. F. LYMAN WELLS 569
German Militarism and its Influence upon the Industries. Dr. HUGO SCHWEITZER 582
Hope for the Russian Peasantry. LUCY ELIZABETH TEXTOR . . . 590
The War and the Weather during the First Three Months of the War. Professor ROBERT DEC. WARD 604
The Progress of Science:
War and Public Opinion; Crystals and X-rays; Natural Scenery for Museum Exhibits; Scientific Items 615
Index to Volume LXXXV 621

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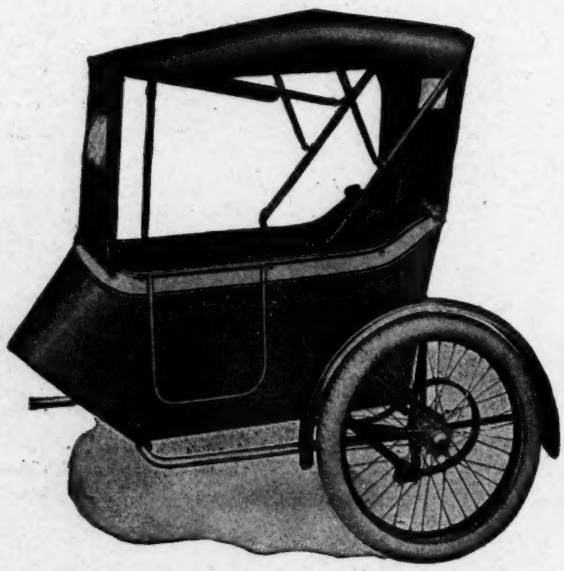

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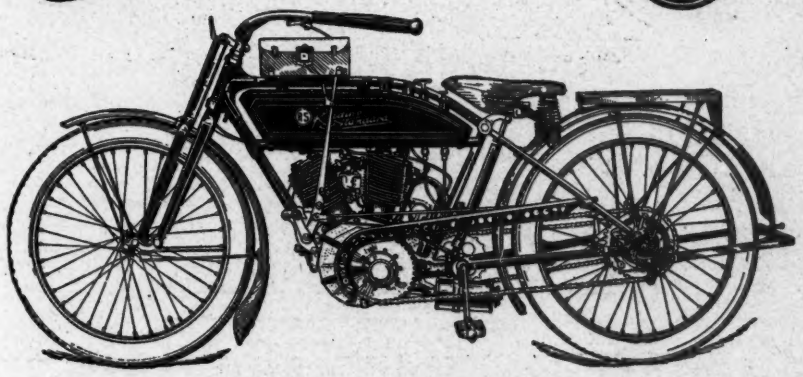

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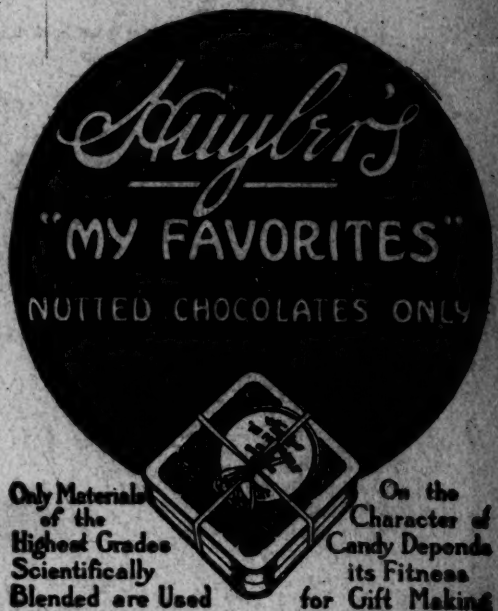

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